J. AGRAVE

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MATHE

MATICAL

JEWEL

LONDON

1585

Samuel Hugonius claynensis pædagogicus et philomathes. prec.

THE MATHEMATICAL IEWEL,

Shewing the making, and most excellent vse of a singuler *Instrument so called: in that it performeth with wonderfull* dexteritie, whatsoeuer is to be done, either by Quadrant, Ship, Circle, Cylinder, Ring, Dyall, Horoscope, Astrolabe, Sphere, Globe, or any such like heretofore deuised: yea or by most Tables commonly extant: and that generally to all places from Pole to Pole.

*The vse of which Iewel, is so aboundant and ample, that it lea*deth any man practising thereon, the direct pathway (from the first steppe to the last) through the whole Artes of Astronomy, Cosmography, Geography, Topography, Nauigation, Longitudes of Regions, Dyalling, Sphericall triangles; Setting figures, and briefely of whatsoeuer concerneth the Globe or Sphere: with great and incredible speede, plainenesse, facillitie, and pleasure:

The most part newly founde out by the Author, Compiled and published for the furtherance, as well of Gentlemen and others desirous of speculatiue knowledge, and priuate practise: as also for the furnishing of such worthy mindes, Nauigators, and traueylers, that pretend long voyages or new discoueries: By *Iohn Blagraue* of *Reading* Gentleman and well willer to the Mathematickes, who hath cut all the prints or pictures of the whole worke with his owne hands. 1585.

Imprinted at London by Walter Venge, dwelling in Fleetelane ouer against the Maiden head.

To the Right Honorable Sir VVilliam Cycill Knight

Baron of Burleigh, Lord high Treſurer of Englande, Maſter of her Maieſties Wards and Liueries, Knight of the moſt honorable order of the Garter, and of her heighneſſe moſt honorable Priuie Counſel.

BEing (Right Honorable) no leſſe then the reſt of my deere friends, full fraught with the feruent and duetifull zeale, wherein the whole progenie of vs are, & ſhalbe euerlaſtingly bound vnto your good L. diuerſe wiſe: namely, for the ſyncere Iuſtice and pittie, or rather piety, ſo charitably extended in our late extreame & moſt iniurious vexation. Sounding in equitie the depth of the monſtrous and deteſtable driftes and deuiſes of thoſe notorious, lewde & wicked practiſers againſt vs, who ſought *Quaq; iniuria*, to ſtrippe vs out of whatſoeuer we poſſeſſed, without any colour almoſt, of matter or cauſe: but onely preſuming and truſting to the packing and corruption of the time, and of our innocencie and inſufficiencie to withſtand their aſſaultes. It were a treble tragedie to declare euery circumſtance: and needeleſſe, the matter being wholly handled ſo ſundrie times before your L. that your L ordſhip no doubt remembreth it: and of vs, who haue all their trecherie in records exemplified, can neuer be forgotten: How wickedly they ſtale away (as they thought) all our euidences, and thereupon by what ſiniſter meanes they wrought her Maieſtie a title: howe cunningly or rather cozeningly they conueyed it againe from her Heighneſſe for three ſcore and ten pounds of money, which coſt my friends almoſt 3000. li. neere 40. yeares paſt: How they alſo altered the tenure from *Capite* to *Socage*, and what vile corruption, notable packing, craftie confederacies, wicked ſubornations, vnconſcionable wreſtings, ſubtill ſhiftings, indirect proſecutions, and vnchriſtianlike dealings they vſed and practiſed, againſt vs poore ſoules euerie way vnable, had not the right of the cauſe found grace before your H. chiefly and other honorable perſonages & good Iudges and Iuſtices of this land, euen to the glory & praiſe of Almightie God in the eye of the world. The continuall remembrance whereof neuer ceaſing: yea rather dayly encreaſing, hath pricked me forth, perhaps (as it may be thought) ſomwhat ouer boldly, al things in equall ballance conſidered, (though of two extremities, I haue rather ſorted to hazard the ridiculous diſdaine of preſumption, then the moſt heinous reproch of an vngratefull minde:) euen to preſent your Honour heere at this time with a *Iewel*, not wrought of Minerals, or ſet with ſtately ſtones, or brought home from beyond the ſeas by ſundry our countrie men, in their venterous and worthy voyages lately performed. But a *Mathematicall Iewel*, of no ſmall vertue and efficacie, to furniſh the willing wits of this our age for the like enterpriſes. Containing in ſum, *A reduction of the Arts Mathematicke tending thereunto, and to diuerſe other good vſes, from that deepe difficultie, wherewith hitherto they haue bene ſequeſtred and cloſed vp as it were in ſeuerall, onely to the learnedeſt ſort: vnto an eaſie, methodious, plaine, and practique diſcipline, lying wide open vnto euerie ingenious practiſer*, whenſe I preſume, many ſinguler inuentions, and notable commodities in time ſhall enſue and ſpring, yea a number yet vnthought of, euen from the common ſort of handie craftes men and trauailers. The which making it no better then it ſhall I hope proue, I moſt humblie craue of your H. to accept at his hands, who thinketh himſelfe in no leſſe good caſe then the happieſt, in that it hath pleaſed God to grant him but this poore meanes, whereby he may attaine to ſhew ſome leaſt ſparke of the vnquenchable fire of his loyal and dutifull zeale towards your H. Humblie ingrating that by your L. good fauour and protection, this little maſſe may be garded and freed from detraction, and the rather borne withall in any eſcape or want, of that others now can or hereafter by gather heereof may ſupplie better, or enlarge. And thus, as moſt bounden in due tie, reddie in ſeruice, and dayly in prayer, vnto Almightie God to be your Honours good guide and fortreſſe both in this life and the life to come, reſt moſt humble at your H. commaund.

Iohn Blagraue.

The Author to the curteous Reader.

IT is ſtrange (gentle Reader) to ſpeake of the breuitie, methode, plainneſſe and facillitie, whereby this *Iewel* performeth all and that with the vttermoſt, which I haue in my title auouched, yea & to be admired, that one onely & ſo ſingle an inſtrument ſhould performe ſo infinite a number of concluſions, more then I thinke I ſhall euer haue time to write, and thoſe no baſe ſtuffe inuented to fill vp a volume as in other bookes are many thruſt in to ſmall purpoſe. Wherefore be not ſparing of a little paines at the firſt entrance to vnderſtand the particularities of your *Iewel* though it ſeeme a little harde, and aſſure your ſelfe being once entred, that neuer inſtrument was more eaſie and pleaſant: the 2. booke eſpecially the ſecond part will, I preſume, ſufficiently inſtruct you. I haue beſides here following ſet an Index or Table directing to the expoſition of any harde terme chancing in the way. Neuer giue ouer at the firſt reading though any thing ſeeme hard rather aske a little helpe. And if yee deſire to be excellent perfite in your inſtrument, abridge my whole worke, and you ſhall finde it will ſtand you in more ſteede then 20. times reading, I haue alwayes done ſo with any booke I liked of. I craue nothing for my part but that ye will lightly paſſe ouer euery eſcape of mine and the Printers, which I doubt wil fal out in ouer many places (the coppy in truth being brought vnto him very defuſe and enterlined) though none I hope ſo great to alter the ſenſe of the matter, which I could not helpe, by reaſon I haue bene wonderfully letted as is too too wel knowne to the world, for theſe 6. or 7. yeares togither in the behalfe of my friends, who were monſtrouſly troubled for no leſſe then their whole liuings & poſſeſſions, wherein my part alſo ſomwhatlay, by certaine promooting mates or to terme them more aptly concealed knaues, who after that ſome of them had (as they thought) filcht away all our euidences, though by the great prouidence of God the chiefeſt were ſtrangly preſerued, then was there no ſubtill, indirect or corrupt dealing to be imagined but they practiſed it againſt vs. For, ioyning with a famous lewde pettifogger they got by his meanes commiſſions out, and offices found vpon ſtelth at pleaſure to entitle the Queene thereto as concealed lands, whereby they had it vnder the broad ſeale before we heard any inckling of it, and came vpon vs with a writ of Intruſion, to farther which action, and others after that: they fell to ſuch packing, ſhifting, ſuborning wreſting ſeducing & ſuch diabolical practiſes & that ſo hardly followed it, that the world was a great whiles *Aequidubium* of our ſucceſſe. It is a world to ſpeak of al their wicked drifts, which bicauſe it would be but a glaſſe, wherein vile people of like diſpoſition might ſee the whole commō welth of villanous trechery, I here omit, togither with their names: and the rather I do it, for that in conſcience I thinke they would reioyce and glory to bee in print though for egregious knauerie, euen like that lewd fellow that ſet *Dianaes* temple on fire to get him a laſting name. And yet one of their auncеſtors in the booke of monuments is in print alredie looking through a Pillorie which I cannot helpe. Wherfore (curteous Reader if any thing be amiſſe blame thoſe catetpillers of the common welth, thoſe vnconſcionable hunters of mens titles, thoſe wicked *Hamons*, being ſuch, of whom it may rightly be ſaid, *Qui nunc in terra, viuunt hic quaſi viuerra, Cuniculos vellens pauperes de limine pellens*, who hindred my trauailes, & brought me dayly out of courſe with my determinations: ſo that commonly at the ende of euery Terme I was with *Penelope* newly to begin againe my webbe. And for one two yeares togither could ſcarce intende to looke on booke, by meanes whereof my minde alwayes being troubled, and partly by meanes of my young yeares, then wanting iudgement when I wrote the firſt coppy of ſome part of this work, I know I haue harſhly written ſome things therin, wel neare vnto the middle of the third booke, which to this day being aboue 7. yeares betweene, leiſure would neuer allow my riper yeares fully to tranlace to my minde, and therfore you muſt vſe a little the more induſtrie to vnderſtand it. For ſince our 6. yeares turmoile in law ended, I haue bene ſo greatly called away with other needfull affaires, and ſo much applied for meaſuring of land, platting ſerueying and ſuch like, that time hath bene ſhorter with me then before. Beſides that I was forced to cut al the prints my ſelfe to my great paines and let of time, that had it not beene for the importunacie of ſundrie Gent. my friends who perceiued the ſinguler commoditie of the inſtrument, that were deſirous to haue me publiſh it with ſpeede, leaſt time ſhould by ſome meanes haue ſet it quite aſide, I would either haue had ſufficient time to haue fined it, and new written the coppie, or ſtaide it ſtill in my ſtudie, but being as it is, I muſt requeſt euery man to take in good part ſome part of my ill hap, promiſing to make amends with a little more diligence in my next ſixe bookes of the *Iewel*, which I purpoſe with as much ſpeede as I can after theſe to publiſh. And thus wiſhing my ſelfe preſent at euery doubt with my hartie good will farewell this 20. of Ianuarie 1584.

The

The Authour in his owne defence.

IF poore man with his paine, May pick vp many a pounde,
If ſtreames with often rayne, May quell the greedie grounde,
If ruſticke ſoyle may yeelde, Both hearbes and flowres faire,
If tylth the hungrie field, May maintaine and repaire:
Then why ſhoulde *Momus* howte, Or cauill at my quill,
To ſee hym now ſend out, That he hath haachte at will?
Or why ſhoulde painfull penne, that long hath toyld in hope,
By meanes of ſpitefull men Be turned all aſlope.
As though the *Muſes* all were niggardes now of late,
And would not let the ſmall To enter at their gate:
Or ſtoupt to none but ſtates, Or lou'd to lodge in Towers,
Diſdaining countrie cates Or courſe contriued bowres.
No no, you neuer knew, That ere they were ſo ſtrange,
And I dare vouche for true They neuer will ſo chaunge.
VVhy? did not they attende *Diogenes* his tubbe?
And meekly to him bend Yea vnder many a ſhrubbe?
And were they not at hand VVith *Arion* on the Seas?
VVith *Orpheus* on the lande Amid the wilderneſſe?
Let no man nowe then doubt But haply I may ſhow
Such ſtuffe as late came out, And did in *Pernaſſe* grow.
Though that my name be not Among the learned rolde.
Let not that bee a blot Ere that my tale be told.
Yet *Zoylus* ſeemes to ſay, VVhy? what? and whence is he?
A childe but yeſterday, And now to ſcale the skie?
VVhere gathered he his skill? VVhat tutor tolde him in?
The Vniuerſities denill That ere he dwelt therein.
And London laughes to thinke She ſcarce doth knowe hys face,
How commes he then to linke VVith *Vranes* worthy grace.
My aunſweare ſhall bee ſhort, My paine this peece hath pend,
God lent it to my lot, And hee ſhall mee defende.
The Pſalmes ſay ſucklinges young His glory ſhall diſcloſe
VVhich warrants me among My wrangling wrabbiſh foes.

I. B.

The Authours dumpe.

VVHo coucheth cloſe in countrie coaſt, the ruſticke *Nymphes* among,
In *Codrus* caue obſcured aye, a farre from any throng,
VVill ſhrinke to come amid the route, that braue in bewties lappes,
That ſit and ſwigge their bellies full, from queene *Mneruaes* pappes.
Lo I the ſame, though lingred long, at laſt am come to light,
But ſtande amazde, a newe come gueſt, I ſeeme in eache mans ſight.
No wight I ſee puttes foorth his pen, my needles prayſe to paint
But euen alone a countrie drone I ſtand in this conſtraint.
Eche paltrie pamphlet in theſe dayes hath praiſers many here,
VVhich mountaines promiſe to the worlde, where mole hilles ſcarce appeere.
If then ſuch praiſes prooue to mockes, and come before their time:
I reake the leſſe, I looke the ende ſhall prayſe this worke of mine.
To thee dame *Vraue* I referre the lot of my ſucceſſe,
Giue me therefore an hapfull houre, then I ſhall care the leſſe.
Graunt *Iupiter* be Lorde thereof, and *Mercurie* aſcendent,
Let *Saturne* ſtande aloofe the whyle, and *Mars* in detriment.
The *Horoſcope* aſpected well his *Lorde* in exaltation,
And Lady *Luna* haſting to ſome bliſſefull application.
My *Radix* with the *fortune partes* to agree thereto take care,
And I thy fame to fling abroade hencefoorth will neuer ſpare.

I. B.

The

¶ A Table of the Contents of all the Chapters *contained in this worke.*

The first booke of this Mathematicall *Iewell* containeth very needefull Geometricall principles which may be called the rules of the compaſſe, *and alſo after that the principles and rudiments of Aſtronomie and Coſmographie.*

OF certaine definitions Geometricall.

CONCLVSIONS

1 TO erect a perpendiculer vppon any point of a groundline aſſigned, and thereby to make a right angle.
To make a right angle another way, and eaſier.
2 To deuide any ſtreight line or arche of a circle into two equall parts very ſpeedily,
3 From a point propoſed to draw a perpendiculer to any ground line.
4 From a point propoſed to draw a perpendiculer to any grounde line another way where the groundline lacketh length.
5 From the extreeme or end of a ground line to draw a perpẽdiculer very eaſily wher the ſame ground line cannot be extended.
6 To doe the ſame more readily another way with once opening of your compaſſe.
7 From a point propoſed to drawe a line parallel to any line propoſed.
8 To make a triangle of any three lines propoſed.
9 To make a ſquare of any ſide giuen,
10 To make an angle equall to any angle propoſed.
11 To finde the very point where the touch line toucheth any circle.
12 To deuide ſpeedily and exactly any line into many equall partes.
13 To prepare a triangle too bee alwaies readie for deuiding of a line exactly into as many euen parts as ſhalbe required.
14 Another ſpeedie way to deuide a line into many equall partes.
15 The ſame a third way and readieſt.
16 Any three prickes howſoeuer not being in a ſtreight line how to deſcribe a circle that ſhall cut them al three.
17 How to finde the center of any circle or arche propoſed.
18 To make an angle equal to any angle aſsigned othertherwiſe then in the 11. concluſion.
19 To deuide eaſily a very ſmall circle into a number of equall diuiſions.
20

Heere followe the principles and rudiments of Aſtronomie and Coſmographie, with the vnderſtanding of euery circle of the ſpheare, and their vocables

CHAP. 1.

VVHat Coſmographie, Geographie, and Topographie are.
2 Of the placing of ſpeeres and the diuiſion of the worlde.
3 VVhat a ſpheare or globe his axtree and poles are.
4 Of the ſixe chiefe great circles of the ſpheare.
5 Of the foure chiefe leſſer circles of the ſpheare.
6 Of the Zodiacke and his diuiſion into degrees and ſignes, and their caracters.
7 A farther diſcourſe of the circles of the ſpheare.
8 Of the circles of the ſpheare chaungeably with euery horizon.
9 Of the motions of the ſpheare, and all the tenne ſpeeres.
10 In what time euery ſpeere and planet finiſheth his courſe, and of the caracters of the planets.
11 Of Zones, Climates, Parallels and Meridianes.
12 Of the longitudes and latitudes of places.
13 Of the Theorickes of the planets.

The ſecond booke of the Mathematicall Iewell, *ſheweth the making of the* Iewell, *and alſo the definition and explanation of this* Iewell, *and of euery circle and part thereof*

CHAP. 1.

A Neceſſary diſcourſe which *Gemma Friſius* vſed as a preamble to his booke *De Aſtrolabio Catholico*, by what reaſon the Globe is brought into a flat or plaine forme.
2 VVhat materiall this *Iewell* were beſt to bee made of.
3 The meridianes and parallels drawen how to finiſh the *Mater*.
4 Howe to finde the centers of the Meridianes three ſeuerall wayes.
5 Howe to finde the centers of the parallels artficially.
6 How to make a *limbe* to the *mater* and the *reete* both out of one peece with all their lineaments.
7 How the zodiacke of this *reete* may be deuided diuers other wayes.
8 How to place the fixed ſtarres in the *reete*.
9 Howe to finiſh and cut out the *reete* of this *Iewell*.
10 How to make the *label* for the *mater* and the rule to the backſide with ſightes.
11 How to furniſh the back of the *Iewel* with the Theorick and other neceſſaries.
12 How to ſet together all this worke of the *Iewel*.

Many

Heere followeth the inuention, definition and explanation of the Iewell *and of euery circle part and thing therein contained.*

13 VVhat moued the Authour to his inuention of this *Iewell* and whence he obtained it.
14 Of the definition of the *Iewel* and his principall partes.
15 Of the diuision or two seuerall distinctions of this *Iewell.*
16 Of the dispositions of the circles both in the *mater, reete,* & *limb,* for the first & chiefest distinction of this Instrument.
17 The circles seruing the first & chiefest distinction knowen by the last chap. how to place them to the lati. of your countrie, where it shall rest fixed to all conclusions a few excepted euen in maner of the globe or speare with a farther exposition of the lineaments of the *Iewell* so placed.
18 Of the dispositions of the circles both in *mater, reete,* & *limb* for the 2. distinction of the *Iewel.*
19 A farther declaration cõcerning the 2. part of this *Iewel* for the Zodiack, generall horiz. & fixed starres
20 How to choose out which of the 90. horizons serueth to euery countrie.
21 How the Zodiacke & fixed starres rise and set on the horizon now founde.

The third booke of the Mathematicall Iewel, *containeth al the propositions & conclusions of all former writers, with diuers new additions.*

CHAP. 1.

HOw by the *Iewel* to take the altitude of the Sun, Moone, or any planet or starre aboue the horizon.
2 How to get or rather examine the Suns greatest declination and distance of the Tropickes and therby also to learne the latitude of any countrey.
3 How by the Theorick on the backe of the *Iewell* to get the sunnes place or deg. in the Zodiack any day.
4 How to finde the sunnes declination for euery day in the yeare, and also the declination of euery part of the Ecliptick.
5 How to finde the latitude or poles eleuation any day proposed in any place or countrey whatsoeuer.
6 How to know what it is a clocke at any time the sunne shining and in any region in the world.
7 The latitude of any place knowen how to gette the declination of the Sunne, or any Starre, Planet or Comet by obseruation.
8 How the latitude or poles eleuation may be had in any region by the starres that neuer set.
9 The lat. knowen how to finde what day of the moneth it is though it were lost, as they say by the Sun shining at noone.
10 To find the right ascension for any portion of the ecliptik, and what degree of the equinoctiall doth coascend or rise together with euery degree of the eclipticke in a right speare.
11 The same more compendiously by the *reete.*
12 VVhat point of the ecliptick it is as well in the first quadrant as in the rest also that hath the greatest difference betweene the arch of the ecliptick, & the arche of the Equinoctiall coascending with him.
13 Of the difference of ascensions. 14 The same very plainely by the *reete.*
15 To know the oblique ascensions. 16 Of discensions both right and oblique.
17 The longi. & lati. of any starres proposed, to know their right or oblique ascens. and how much they decline from the equinoctiall, and how to place starres in the *mater* of the *Iewel.*
18 The declination of fixed starres proposed with their latitude which neuer altereth, how to finde their longitude in the Zodiacke.
19 The difference of ascension of any part of the zodiacke, or fixed starre proposed or the oblique ascension to know what the latitude of the countrie is.
20 To find the amplitude of the rising & setting of the Sunne or starres.
21 The amplitude of the rising of any knowen starre giuen, or of the Sun with his place in the Zodiacke to know the latitude of the countrie agreeable.
22 To know the rising and setting of the Sun & the semidiurnal arch of the Sun & starres.
23 The quantitie of the longest day of any countrie proposed, how to get the eleuation of the pole there and of the distinction of the climates and parallels.
24 To know what houre of ☽ day or night, the Moone or any planet or star riseth or setteth on the horiz.
25 To know what starres neuer rise or set to euery region, and which are verticall.
26 Of the Cosmicall, Eliacall, and Acronicall, rising and setting of the starres.
27 How to know what it is a clocke in the night time by the starres.
28 Of vnequall or planetarie houres.
29 How by the *Iewell* to know the meridian or greatest altitude of the Sunne and starres.
30 How to find the degree of *medium cœli* or culmination, called midheauen at any time proposed.
31 To knowe how much any degree or point of the heauen is distaunt from the meridian at any time by degrees of the equinoctiall.
32 How by the *Iewell* to know the height of the Sun aboue the hori. euery houre & time of the yere sitting within dores, and thereby to make tables to any lati. for making of particuler dials, as cilinders, ringes, quadrants and such like.
33 How to know the height of any star aboue the horizon sitting close within dores, & thereby to learne to know the starres in the skie.
34 How to find the meridian line, and the foure quarters of the world called *cardines,* diuers wayes, and specially by the Astrolabe.
35 The meridian found, to finde the azimuth of the Sunne or starres by sight without the houre.
36 The verticall circle of the Sunne or anye starre the degree of the Sunne with their altitude aboue the horizon giuen, how to know the latitude, and what it is a clocke.

37 The latitude, the Sunnes azimuth, and almicantare giuen to finde his place in the Zodiacke.
38 To know what houre the Sunne or any ſtarre cometh to any azimuth propoſed.
39 A comet, a planet, or any vnknowen ſtarre being ſeene in the skie, how to get his longitude and latitude in the Zodiacke, and how by the right aſcenſion and declination of any ſtarre to get his longitude & latitude.
40 How to knowe the quantitie of the angles which the ecliptick maketh with the meridian at any moment.
41 To do the ſame another way.
42 Howe to finde the Horoſcope called the aſcendent at any time appointed.
43 How to finde the Horoſcope or aſcendent another way by the *mater*.
44 Of the 12. houſes, and what a circle of poſition is.
45 To finde the circle of poſition according to *Ioh. Regiomontanus* and *Campanus* of any Point propoſed, and how much the pole is eleuated aboue any ſuch circle.
46 Of the other eight houſes according to *Regiomontanus*, and how to ſet a figure.
47 Of the other eight houſes according to *Campanus* and *Gaſulus*.
48 To know in what houſe any ſtarre is at any inſtant, and to place the chiefe ſtarres in the 12. houſes.
49 Of directions, what direction is, and by what meanes it is perfourmed.
50 Of conuerſe or euerſe direction or dimiſsion.
51 How farre or into what part of the Zodiacke dimiſsion or direction ſhall come any yeere.
52 To find what deg. of the ecliptick occupieth any circle of poſition at any time.
53 To know the quantitie of the angle of the inclination of the Ecliptick too the horizon at any degree of the ecliptick.
54 How to finde the altitude of the Sun or any point of the ecliptick aboue the horizon at any time otherwiſe then hath yet been ſhewed.
55 To finde what angles the circle of altitude maketh with the ecliptick at any point thereof aſsigned.
56 How to finde the *parallaxis* or diuerſitie of ſight of the Moone in the circle of altitude.
57 How to finde the *Parallaxes* of the Moone or any other planet or ſtarre, in longitude and latitude of the ecliptick.
58 How to finde when the eclipſe of the Sunne ſhall bee.
59 Another maner to finde out the *Parallaxes* in longitude and latitude aſwell in the Sun, as the Moone.
60 To finde the latitude of the Moone.
61 How much of the Sunne ſhall be darkened.
62 How long the eclipſe of the Sunne ſhall endure.
63 Of the eclipſe of the Moone, the greatneſſe and duration of the ſame.
64 How to get the *parallaxis* of the Moone out of the heauens at any houre propoſed the latitude knowen with the longitude and latitude of the Moone.
65 To knowe the greateſt or horizontall *Parallaxis* of the Moone when ſhee is to be ſeene.
66 The longitude and latitude of the two ſtarres giuen him to know the diſtance between them.
67 How the diſtance of any two ſtarres vnknowen may be had.
68 To knowe howe long the tayle of a Comet is.
69 Another way to ſearch the diſtances of ſtarres one from another.
70 The longitude and latitude of two ſtarres giuen to get the angle of ſtation of one from another.
71 To knowe whether three ſtarres or cities be in one great circle.
72 That the tayle of a comet extendeth it ſelfe directly from the Sun, and how you may trie it.
73 To know what point of the heauen is in the merid. of any place at any inſtant propoſed, and what it is a cloke in any other countrie.
74 How to direct a ſhip by the ſtarres in any voyage.
75 To make an horizontall and South wall diall by the *Iewel*.
76 To finde the declination of any wall from the South, ane fitting a diall therto.
77 How to know the oblique aſcenſ. of any deg. of the zodiack, or of any ſtar, the difference of aſcenſion not regarded.
78 The oblique aſcention giuen to finde the deg. of the zodiacke coaſcending.
79 Of the recourſe & reuolutions of the yeeres of the world, neceſſary in natiuities & directions.
80 Of progreſſions and diuiſions as they be called.

The fourth booke of the Mathematicall Iewell *containing diuers other Aſtronomicall propoſitions and vſes of the* Iewell *of the authours owne inuention.*

CHAP. 1.

AN aduertiſement of the authour concerning neceſſary inſtruments.
2 How to make an inſtrument of 3. ſtreight rules better then any compaſſes to deſcribe any arch with, bee his center neuer ſo far of.
3 The vſe of the former inſtrument in drawyng of any arch.
4 Of a certaine ſecrete in diuiding the meridianes of great Inſtruments.
5 Another ſecrete founde by the Authour in deuiding the parallels of great Inſtruments.
6 Of drawing and diuiding the ecliptick line on the *mater*.
7 By the verticall circle or azimuth of the Sun or ſtarres taken to know what it is a clocke very certainly and exactly.
8 By the lati. of any planet & his diſtance from any knowen fixed ſtar had, how to get his exact lõgitude.
9 How at all times you may behold on the *mater* of your *Iewel*, the whole circumference of the ecliptik according to his ſituation aboue the horiz. which bringeth with it pleaſant vſes as followeth.

10 By the Eclipticke circle conſtituted as in the laſt chap. how to get the altitude and azimuth of the Sunn or any point of the Eclipticke, and therby alſo of the other planets ſo they haue no latitude.
11 By the ſame conſtitution of the Eclipticke circle how to finde his *nonages of grad*, with the altitude therof, being the quantity of the angle made betweene the Eclipticke and the horizon.
12 How by the ſame conſtitution of the Eclipticke to ſee all the circles of poſition liuely on the *Iewell* and what deg. of the Zodiacke is in any of them.
13 How by the ſame conſtitution of the Eclipticke circle to ſet a figure very ſenſibly and apparantly.
14 How to ſet a Figure with more pleaſure and eaſe, the laſt chap. wel vnderſtood, ſo that you may behold your whole 12. houſes in their beyng altogether on your *Iewel*.
15. How by the 11. chap. to get the altitude of the *nonages. grad.* more readily then there is expreſſed.
16 How to place the Eclipticke aboue the *Finiter* after another ſort then is ſhewed in the 9. chap. and in the ſame conſtitution to find out euery needful circle wherby moſt excellent concluſions are to be performed.
17 How by the conſtitution of the 16. chap. to get both the altitude and azimuth of the Sun or any point of the Eclipticke or of any other planet or ſtarre how much ſoeuer they ſhalbe in latitude.
18 How by the conſtitution of the Eclipticke as in the 16. chap. to get the longit. and latitude of any ſtarre or planet, that is to be ſeene in the skie: and therby alſo his right aſcenſion and declination.
19 The latitude and azimuth of the Sun or any planet or ſtarre being taken, howe by the conſtitution of the 16. chap. to get their exacte longitude.
20 How to get the true and exact azimuth of any comet, planet, or ſtarre vnknowne.
21 The moone ſhining on any Sun diall, to know in the night what it is a clocke very ſpeedily by helpe of the *Iewel*.
22 A ſpeedy way to know what it is a clocke by the ſtarres, without taking their altitude.
23 The vſe of the 3. tables comprehended in the 2. Figure of the 2. booke 13. chap.

The 5. booke of the Mathematical Iewell, *teaching moſt plainly to performe on the* Iewell *the whole art of ſpherical triangles, and may be called the key of the knowledge of the ſpheare.*

CHAP. 1.

OF the expoſition of a Sinicall quadrant, and al things thereto appertayning.
2 Of certaine definitions needful to the better vnderſtanding of this woorke.
3 Of certain Theoremes needful to be premiſed for the better vnderſtanding of this my preſent work of ſpherical triangles.
4 If of a right angled ſpherical triangle two ſides ſhalbe knowne, how to get the quantity of the third ſide, and the other 2. angles.
5 The declination of the Sun, moone, or any other planet or ſtarre from the Equinoctiall giuen together with the latitude of the countrey, how by the 4. chap. to get the amplitude the difference of aſcenſion, the oblique aſcenſion and the diurnall arch of any of them.
6 To performe the 4. chap. on the *Iewel* by another maner of working.
7 To performe the ſame by the *Iewel* after a third manner.
8 The quantity of the longeſt day in any countrey giuen, to know the latit, & in what climat the ſame is.
9 If one ſide, of a right angled ſpherical triangle with one of the two angles not right bee giuen, howe to fynd the other two ſides and angle.
10 If you would make an horizontall or vertical dial to any countrey, how by this laſt chap. to fynd what number of deg. euery houres ſpace containeth.
11 If the 3. ſides of any ſpherical triangle whatſoeuer ſhalbe giuen, to fynd the quantity of euery of hys 3. angles.
12 The declination of the Sunne giuen at anye time together with her altitude aboue the horizon how by meane of the 11. chap. to get what houre and minute it is, and in what azimuth the Sun then is.
13 If of a ſpherical triangle 2. ſides containing any one knowne angle ſhalbe giuen how to fynd the other ſide and angles.
14 How by the helpe of the 13. chap. to know the height of the Sun at any houre and min. propoſed in the whole yeere, and alſo in what azimutth he is.
15 *Ioan. Regiomon. lib. 1. cap. 51. & lib. 4. cap. 29.* propoſeth and ſaieth that the knowing of two ſides of a triangle not right angled with one angle ſubtended by one of thoſe ſides, cánot ſerue to get the other ſide & angles.
16 The azimuth of the Sunne giuen or taken at any time by the inſtrument with his declination, howe by helpe of the 15. chap. to know what height the Sun is of, and what it is a clocke.
17 If of any ſpherical triangle not right angled, 2. angles ſhalbe giuen with the ſide lying betweene thoſe angles or els the ſide ſubtending one of them, how to get the other two ſides and 3. angle.
18 How by help of the 17. chap. to make any declining diall, that is to ſay a diall to any wall ſhouldring or bending from the ful beholding of the South.
19 How to let downe a perpendiculer arch from any angle of a knowne ſpherical triangle vnto his baſe or ſubtending ſide, and to know the quantity of the ſame perpendiculer and of the partes wherinto hee deuideth the baſe.
20 To doe the ſame after another maner of working, yea though one of the other 2. angles, and one of the other 2. ſides of the triangle were vnknowne.
21 If 2. great circles of the ſpheare croſſe one another, making a knowne angle howe to get the perpendiculer arch falling from any point aſſigned of the one circle vnto the circumference of the other, together with the arch of the ſame circle betweene the perpendiculer and the croſsing.
22 How by helpe of the 21. chap. to know both the height of the cocke to anye declining diall, and howe much

much he muſt be placed byas from the perpendiculer which I cal his deflexion.
23 In a right angled ſpherical triangle where one of the angles ſhal chaunce to be but certaine minutes as it oft happeneth, how to get the ſide ſubtending that angle preciſely notwithſtanding.
24 If the 3. angles of a right angled ſpherical triangle ſhal be giuen how to get the quantity of the 3. ſides vnknowne.
25 If by the croſſe ſtaffe or other inſtrument you ſhall take the true diſtance of any planet, comet, or ſtarre vnknowne from two known ſtarres, how by the helpe of this my worke of ſpherical triangles, to get the longitude and latitude in the Zodiacke of the ſame planet, comet, or ſtarre, and alſo his declination and right aſcenſion: and what you had neede to do in all ſpherical queſtions.

The 6. booke of the Mathematical Iewell, *ſhewing the Theoricall reaſon, ground, and making of all dialles.*

CHAP. 1.

O certaine preambles to be noted in vnderſtanding this worke following.
2 Of the dyſtinction of dials into 2. kinds, Inſtrumentall and ſpherical.
3 Of the definition and deriuation of dials, and the ground of them all.
4 VVhat the cocke or Gnomon of enery diall is, & by what reaſon they giue the true ſhade to the diall.
5 Of the diuiſion of horizons, and eſpecially into 3. ſorts.
6 Of the diuiſion of al dials into 3. ſorts, & why they make ſhew of greater diuerſity then there is.
7 How to make the firſt kind of dial to the Equinoctial horizon, that is, where one of the poles is Zenith.
8 How to make the ſecond kind of dial to a right horizon, that is, where the Equinoctial cutteth the Zenith, together with the ground and reaſon of all dialles to any right horizon.
9 How to make the third kind of diall to an oblique horizon, which they commonly cal an horizon dial, & that very eaſily.
10 How to make a dial to a perpendiculer wal beholding the ſouth, called of ſome authors *Horologium vertica.*
11 To make a dial to a ful North wall.
12 How to make a dial to an Eaſt wal.
13 How to make a diall to a VVeſt wall.
14 Of declining walles and what circles of the ſpheare they repreſent.
15 How to know the ſcituation of any wall, and to find how much he declineth.
16 How by the declination of any wall known to finde his eleuation with his angle of deflexion.
17 To performe the laſt chap. a ſecond way by the 6. chap. of ſpherical triangles.
18 To performe the ſame a third way.
19 How to make a dial to any declining wall reſpecting the South.
20 How to make a diall to any declining wal reſpecting the North.
21 How to order dialles that decline very farre Eaſt and VVeſt.
22 Of walles reclining and inclining, and of the diuerſity of them.
23 How to take the reclination or inclinatian of any wal or flat, together with his declination if any be.
24 How to make a dial to a South or North reclining or inclining wal, banke or flat.
25 How to make a diall to an Eaſt and VVeſt wall, banke, or flat, reclining or inclining.
26 How to find the angles of the poles eleuation, dialles deflexion, and meridians aſcenſion to any reclyning or inclining wall declining.
27 How to perform the laſt chap. by ſpherical triangles very eaſily & with great pleaſure and profite.
28 The angles of reclination, declination, eleuation, deflexion, and aſcenſion had as before, howe to make the diall to a reclining wal, banke or flat declining.
29 Of inclining dialles declining.
30 How to know in what countrey any declining, reclining or inclining dial woulde, or of right ſhoulde ſerue as an horizon dial, & alſo to make him ſhew the houres of the ſame place together with yours.
31 How to place a flat repreſenting the horizon of any countrey, city or place in the world both according to the longitude and latitude of the ſame.
32 To performe the ſame by ſpherical triangles.
33 To deſcribe al maner of declining dials, & alſo the Eaſt and VVeſt reclining and inclining more at pleaſure then yet hath bin ſhewed, without foreknowing the angles of eleuation and deflexion.
34 To reduce al reclining and inclining flats declining vnto Eaſt & VVeſt reclining & inclining flattes to ſome one latitude or other, and thereby moſt eaſily to make dials.
35 To doe the ſame ſomewhat eaſier.
36 To performe the 31. chap. more eaſily, or at the leaſt more pleaſingly.
37 A moſt eaſie and briefe way to reduce al reclining & inclining flats declining vnto Eaſt and VVeſt, reclining flats to a new latitude otherwiſe then in the 34. & 35. chap. by helpe of ſpherical triangles.
38 A brief note how Eaſt & VVeſt reclining or inclining dialles are to be made 2. ſeueral wayes.
39 How to make a dial to any Eaſt or VVeſt, reclining or inclining flatte by helpe of ſpherical triangles moſt eaſily.
40 Moſt excellently and eaſily to make al manner of reclining flats declining by the *Iewel* and help of ſpherical triangles.
41 To know in what longitude and latitude, our horizon, or anye other ſhall repreſent any declining wall propoſed, or els any circle of poſition propoſed.

An Index or Table directing any man vnto such places in this booke where al the termes hereafter following, are defined and expounded. The first number signifiyng the booke, the second the chapter.

A

Angle right, sharp or blãt, 1.0.
Arch. 1.0.& 5.1.
Axtree of the world, 1.3.
Articke circle, 1.5.
Antarticke circle, 1.5.
Azimuthes, 1. 8.& 2.18.
Almicantares, 1.8.& 2.18
Apogeon, 1.13.
Aux, Idem.
Absis. Idem.
Equinoctial of the sphere. 1.4.
Aetheriall parte of the worlde. 1.2.
Aequans. 1.13.
Aequinoctium. 1.4.
Astrolabe. 2.16.
Equinoctial of the *Mater.* 2.19
Axtree. Idem.
Apex. 2.21.
Altitude. 3.1.
Equinoctials height. 3.7.
Ascension. 3.10.
Amplitude. 3.20.
Acronical rising & setting of starres. 3.26.
Angle of the earth. 3.30.
Ascendent. 3.42.
Apheta. 3.49.

B

Base line. 6.23
Basẽ line perpẽdiculer. Idẽ

C

Circle. 1. 0.
Center. Idem.
Chorde. 1.0.& 5.1.
Circumference. 1.0.
Cosmography. 1.1.
Corography. 1.1.
Colures. 1.4.
Caract. of the signes. 1.6.
Circles of station. 1.8.
Circles of position. 1.8.& 3.44.
Caracters of the planets. 1.10.
Capus draconis. 1.10.
Cauda draconis. 1.10.
Climates. 1.11.& 3.23.
Culmination. 3.30.& 3. 11.
Cardines. 3.34.
Coniunctio visa & vera. 3.62.
Comet. 3.72.
Complement. 5.1.
Cosmical rising. 3.26.

D

Diameter. 1.0.
Degr. of the Zodiack. 1.6.
Difference of longit. 1.12
Deferentes Apogeon or *Excentricum*, 1.13.
Deferens Epicyclum. Idem.
Direct. Idem.
Deuiding boord. 2.2.
Degree. 3.1.
Declination of the Sun or starres. 3.7.& 3.4.
Differẽce of ascensiõ. 3.13
Diurnal arch. 3.22.
Direction. 3.49.
Dimission. 3.49.
Direction conuerse. 3.50.
Diameters of the earth, sũ and moone. 3.63.
Diuisions. 3.80.
Diall. 6.2.
Declining walles. 6.14.
Declinatiõ of a wal. 6.14.
Deflexion. 6.16.& 6. 27.

E

Elements. 1.2.
Elemental part. Idem.
Ecliptick. 1.6.
Excentricitye of the planets. 1.13.
Ecliptick of the *mater.* 2.19
Eclipse of the sun. 3.63.
Eclipse of the moone. Idẽ.
Eleuation of a wal. 6.16.

F

Flat. 1.0.
First mouer. 1.9.
Finitor. 2.18.
Finitor to the latitude. 2.19

G

General horizons. 2.6.
Ground line. 1. 0.
Great circle of the sphere. 5.2.
Great circles, axetree and poles Idem.
Geography. 1.1.
Globe. 1.3.

H

Horizon. 1.4.
Houre lines. 1.7.
Hori. *rectus & obliquus.* 2.19
Houre lines of the *Mater.* 2.19.
Heliacall rising & setting of starres. 3.26.
Horoscope. 3.42.
Houses of a figure. 3.46.
Horizontal parallax. 3.56
Horizons poles. 6.1.
Horizon *rectus, Equinoctialis, obliquus.* 6.5.

I

Imum Cœli. 3.30.
Including side. 5.2.
Inclining walles. 6.22.
Inclination. 6.23.

L

Line. 1.0.
Lines parallel. Idem.
Lines spirall. Idem.
Long square. Idem.
Loseinge. Idẽ.
Likeiame. Idẽ.
Latitude of planets. 1. 10.
Longit. of regions. 1.12.
Latitude of regions. Idem
Longitudo longior. 1.13.
Longitudo propior. Idem.
Longitudo media. Idem.
Limbe of the *Iewel.* 2.16.
Latit. of the moone. 3.60
Latitudo visa & vera. 3.62.
Label. 2.16.

M

Meridian circle. 1.4.
Minutes. 1.6.
Meridians. 1.7.& 1.11.
Motion of the first mouer. 1.9.
Medius motus. 1.13.
Mater. 2.16.
Meridi. of the *mater.* 2.19.
Meridian altit. 2.18& 3.29
Medium cœli. 3.30.
Meridian line. 3.34.
Meridians ascension. 6.26
Motus visus & verus. 3.62.
Mediatio cœli. 3.11.

N

Nadir. 1.8.
North horizons. 2.21.
North signes. 2.21.
Nonagesf. gradus eclip. 3.53.

O

Opticke. 2.1.
Oblique ascension. 3.10.
Oblique ascending signes. 3.13.
Oblique horizons. 6.5.
Oppositum angis. 1.13.

P

Parallel lines. 1. 0.
Point. 1.0.
Perpendiculer. 1.
Poles of the world. 1.3.
Parallels of declinatiõ. 1.7
Poles of the horizon. 1. 8.
Proper motion of the spheares. 1.9.
Parallelles of Cosmography. 1.11. & 3.23.
Perigeon. 1.13.
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Parallelles of the *mater.* 2. 19.
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Planetary houres. 3.28.
Palallaxis of altit. 3.56.
Parallax. of longitude and latitude. 3.57.
Progressions. 3.80.
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Primum mobile. 1.9.
Pole Zenith. 6.1
Pole Nadir. 6.1.

Q

Quadrant. 5.1.
Quadrant Sinical. Idem.
Quadrantes base and side. Idem.

R

Right ascension. 1.7. and 3.7.
Retrograde. 1.13.
Reete. Idem.
Rule. 2.16. and 2.18.
Right horizon. 3.7.
Recourse. 3.79.
Reuolutions. Idem.
Right Sine. 5.1.
Reclining walles. 6.22.
Reclination. 6.23.

S

Spiral lines. 1.0
Semidiameter. 1.0.
Square. Idem.
Speeres of planets. 1.2
Sphere. 1.3.
Sommer Solstice. 1.5.
Solstitium hybernum. Idem.
Signes of the ☊odiack. 1.6
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Speere. 1.9.
Stacionary. 1.13.
South horizons. 2.21.
South signes. 2.21.
Suns greatest declina. 3,2.
Signes right ascend. 3.13.
Semidiurnal arch. 3.22.
Syne. 5.1.
Syne totall. Idem.
Sinus rectus & versus. Idem.
Supplement of a Sine. Idẽ.
Spherical angle. 5.2.
Spherical triangle. Idem.
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T

Touchline. 1. 0.
Topography. 1. 1.
Triangle. 1.0.
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V & VV.

VVorld. 1,2.
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Vertical point. 1.8.
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Z

Zodiacke. 1.4.
Zodiacks breadth. 1.6.
Zenith. 1.8.
Zones. 1.11.
Zenith poynt of the *Reete,* 2.18.
Zenith line of the *Reete.* 2. 19.

Of certaine ſupplies for the better finiſhing of the figure of the Iewell *ioyned to this booke, and firſt for the* Mater *and his* Limbe.

YOu ſee that in the vndermoſt halfe A D B of the vttermoſt ſpace of the *Maters Limbe*, there are certayne great blacke numbers ſeruing indeede to the houres of the night, the very like muſt you ſet in the other halfe A C B in redde inke to ſerue the day houres, then in the middlemoſt ſpace of the *Limb*, which you ſee numbred from the Equinoctial C D ending at either pole in 90. I would haue you ſet the like numbers in redde ynke beginning from either pole and ending at the Equinoct. C D with 90. So much for the *Limbe*.

Now for the *Mater* I would haue you with a pen or penſil, & very good ynke or colour, make euery 3. meridian counted on ech way from the axetree line ſo much bigger, that they might eaſily be ſeen from the reſt, which is done for eaſe of memory & ſpeedy nũbring them. But on this condition, that thoſe aboue the axtree line towards C be done with red ynk or colour, the other with black. So much for the *mater*, the reſt you may learn in the 2. book 3. chap. but that I would haue the Figures of the houre circles ſeruing to the day, and the caracters of the South ſignes to be red, the reſt blacke: and if you doe guild the tropicks, pole circles, axetree, Eclipticke and Equinoct. line, then would the ſpheare ſhew in kinde.

Now for the Reete.

FIrſt read ouer the 2. booke 6. 8. & 9. chap. then would I haue the ſouth half of the zodiack caractered and nũbred with red ynke, & likewiſe the ſouth ſtarres a litle ſhadowed, & their names written in red, the reſt al in black. As for cutting out of the *reete* it is taught in the ſaid 9. chap. or rather the 4. book 1. chap.

Of the Theoricke or Calender.

TO ſaue the making of a ſeueral print, I haue placed the circles & diuiſions of the Theoricke on the out ſide of the *reete*, and are to be cut off from the *reete* in the circle A B C D deſcribed, as you ſee through the middeſt of the innermoſt graduation onely touching the extreames of the zodiack C and D. And therin write the monethes and dayes of the whole yeere as I haue begunne with Ianuary, and the names of the ſignes as I haue begun with Aries: alſo the ſaints daies or names as in the 2. booke is ſhewed, which done clap it on the backe of the *Iewel*, ſo that the centre agree thereto, and within it you may place what deuiſe lyketh you beſt.

Laſtly, whereſoeuer I haue committed any fault by ſlip of knife for want of handineſſe, beeing that theſe were the firſt that euer I cut, I muſt requeſt you to amend it with your pen, and aſſure your ſelfe if you handle this paper inſtrument wel in the paſting that he retch not. and take care in the cutting out of the branches & barres, he wil ſerue you a long time to better vſe then one of mettall, beeing charily kepte, if you get very fine paſtboord made of purpoſe, and then ſpred your paſte very fine thereon, & quickly laying on this picture & clappe it ſtreight into a preſſe before it bee thorowe wette with the paſte, ſo maye you keepe it from retching. I would wiſh you to make experience by ſome other peece of paper of like bignes firſt before you vẽture your picture.

Faultes eſcaped.

PAge 2. *line* 42. *for* D N *reade* N, *pag.* 2. *line* 52. *for* D E B *reade* D E. *pag.* 10. *line* 34. *for my Iewel reade on my Iewel, pag.* 11. *line* 23. *for* D E *read nothing. p.* 13. *l.* 4. *for* vz. M A. *read in* A. *p.* 13. *l.* 5. *for* M A *read in* A. *p.* 13. *l.* 9. *for from read for, p.* 16. *l.* 7. *for* 108. *read* 180. *p.* 20. *l,* 24. *for firſt read fift. p.* 21. *l.* 30. *for one of the Limb read on the Limbe. p.* 24. *l.* 30. *for line leuel read line of leuel. pag.* 27. *l.* 47. *for* 60. *out of* $60\frac{1}{3}$. *read then taking* $38\frac{1}{3}$. *out of* $60\frac{1}{3}$. *pa.* 29. *l.* 53. *in the centre read the centre. pag.* 32. *l.* 21. *for oblique aſcenſ. read oblique deſcenſion, p.* 35. *l.* 4. *for and a halfe the reade and halfe the: p.* 35. *l.* 44. *for layd the deg. r. lay the deg. p.* 38. *l.* 8. *for diſtãce from r. diſtãt from: p.* 38. *l.* 19. *for but the Finit. r. but meue the Finit. p.* 44. *l.* 27. *for point found. r. point: p.* 45. *lin.* 15. *for of the* 12. *houſes, r. of the* 12. *houſe. p.* 49. *l.* 14. *for* $7\frac{1}{2}$. *of the clock r.* 7. *of the clocke: p.* 49. *l.* 26 *for vpwards* 20. *deg. r. vpwards* 90. *deg. p.* 49. *l.* 38. *for of the limb on the r. on the lymb of the: p.* 51. *l.* 9. *for which luminares r. which the luminaries: p.* 51. *l.* 51. *for I would needs, r. example, &c. p.* 51. *l.* 59. *for his muſt r. this muſt: p.* 52. *for* T H G *of the* ☉ *r.* T G *of the* ☉: *p.* 53. *l.* 32. *for* 53. *almoſt r.* 35. *almoſt: p.* 54. *l.* 36. *for Sunne r. ſumme: p.* 58. *l.* 4. *for with the diſt. read which is the diſt: p.* 58. *l.* 8. *for* M T *r. in* T: *p.* 69. *l.* 23. *for thence from the r. thence on the: p.* 72. *l.* 40. *for ſhewing her r. sheweth her: p.* 72. *for the alzit. and aẕim. r. the latitude and aẕim. p.* 76. *l.* 40. *for in euery* 90. *deg. r. in euery parte* 90. *deg. p.* 77. *l.* 34. *croſſing* M A *r. croſſing in* A: *p.* 79. *l.* 1. *for* G D *or* M *r.* G D *or* V M: *p.* 81. *l.* 6. *for* C B *knowne r.* C B *vnknowne: p.* 87. *l.* 22. *for to be* A K *rea.* A K: *p.* 87. *l.* 29. *for in* A. *from r. in* A A. *from: p.* 87. *l.* 52. *of the ſaid r. or of the ſaid: p.* 8. *l.* 24 *for and the* $17\frac{1}{3}$. *r. and the pole* $17\frac{1}{3}$. *p.* 93. *l.* 56. *for yet knowne r. yea knowing: pag.* 104. *l.* 49. *for Iewell or meridian r. Iewell our meridian. p.* 107. *l.* 33. *for* A *plumbe for the flat reade* A *plumbe from the flatte: pag.* 109. *lyne* 19. *for this complement reade his complement pag.* 111. *li.* 18. *for placer. plat: p.* 111. *l.* 22. *for* A K C *r.* A K G: *pa.* 111. *lin.* 24. 55. *deg. r.* 56. *deg. pag.* 112. *for delination of inclining dials reclining read declination of inclining dials declining. pag.* 119. *lin.* 29. *for Balusnus read Balbinus.*

TO Gentle Reader, take a litle paynes to amend theſe ſmal faults which I wold aduertiſe you to do before you read the booke. Though the ſence of the matter and the figures explaning the meaning would, I know, haue cauſed the learned to eſpie theſe faults eaſily: yet for eaſe of the yoũg learner, I haue taken this paines to ſhew them downe: note that in numbring the lines for theſe faults I haue neuer accounted the title of any chap.

Note alſo that a little before the impreſſion I left 2. chapters out at the beginning of the 2. book, & therfore you ſhall find in the reſt of the bookes, the 2. book 20. chap. auouched when it is meant now the 18. and the 21. when it is the 19. & ſo of the reſt, which I though good to warne you of.

The first booke of the Mathemati-

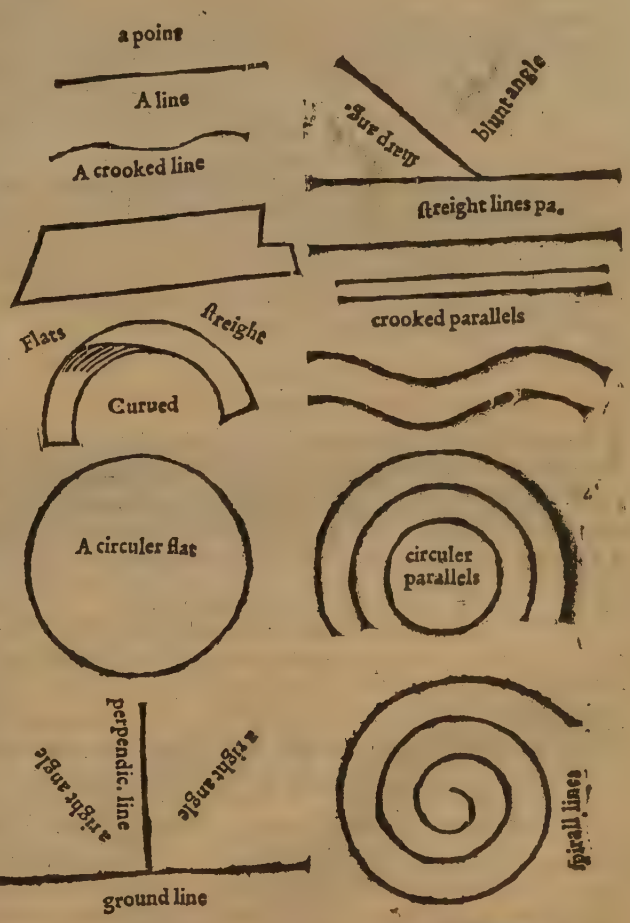
call Iewel: set foorth by Iohn Blagraue of Reading, Gentleman,

Conteineth very needfull Geometricall principles, which may be called

the rules of the compasse: it containeth also after that, the principles and Rudiments of Astronomie and Cosmographie, set downe as the first footesteppe for the vnlearned, which I aduertise the learned to passe ouer.

Of certaine Deffinitions Geometricall.

KNOWING how needfull & speedefull it is as well to the making of this *Iewel*, as also in dyalling and all other Mechanicall working of Mathematicall deuises to haue a handines & dexteritie in the vse of the rule and compasse: for contriuing and disposing of angles, lineaments, and inuentions to euerie purpose and conclusion: therefore for those that haue not beene elsewhere studied in Geometrie, I could not choose but set downe these principles and conclusions following, that the sequeale of my booke might be the better vnderstood and practised.



1 A *point* is a pricke indiuisible or rather imagined, or that hath neither length nor bredth.

2 A *line* is a length without bredth whose extreames are two points.

3 A *Superficies* or flat is the vppermost face of any thing, a bredth without thicknesse and bounded with a line or lines.

4 An *angle* is the touching of two lines not lying in one streight line.

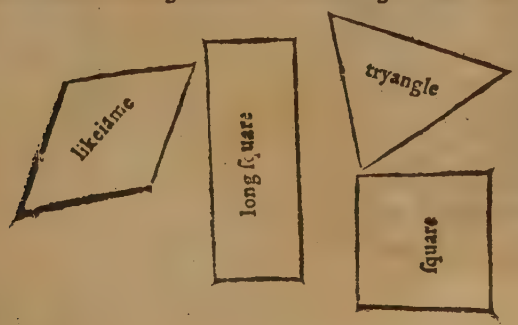
5 A *perpendiculer* or plum line, is a line lighting on another line, making therewith two equal angles, on ech side one: which are called right angles. And the line whereon the perpendiculer lighteth is called the ground line.

6 An *angle* lesse then a right angle is called a sharp angle and that which is greater then a right angle, is called a blunt angle.

7 Those lines are called *parallell* lines whether they be streight or crooked which are drawne ech where of like width: and being drawne foorth infinitely will neuer meete.

8 A *spirall* line is a line representing manie circuler paralels and yet is but one onely line of some called a wormeline.

9 A *circle* is made by the reuolution of a streight line, his one end remaining fixed: of circles the ring is called the circumference: the prike in the middest the centre: and any streight line crossing the centre is called the diametre; and halfe that the semidiametre: any other line in a circle is called a cord, and the portions of the circumferēce answering those cords, are called arches.



10 A touch line is

when a line doth onely touch a circle.

11 A tryangle is a flat of three sides.

12 A square is a flat of foure equall sides, and foure right angles.

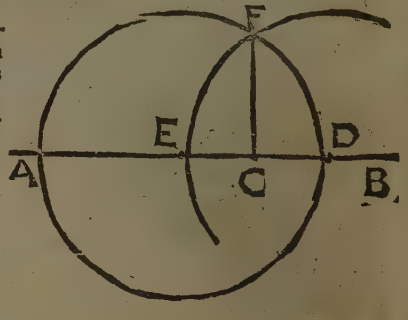
13 A long square is a flatte of foure right angles the sides vnequall.

14 A loseing is a flatte of foure equall sides whose opposite angles be also equall.

Diuerse other superficiall figures there are as well regulare as irregulare vppon whose definitions it were superfluous for me to stande, since I entend to entreate of Geomatrie no farther then is requisite to the vnderstanding of this worke of the *Iewel*.

The first conclusion.

How to erect a perpendiculer vppon any point of a groundline assigned: and thereby to make a right angle.

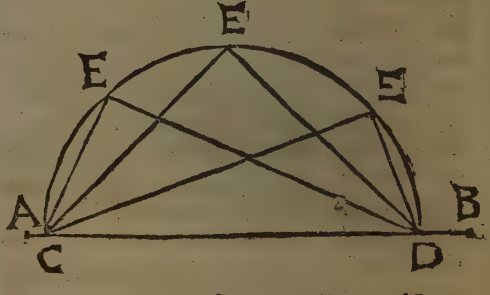


FOr example I would erect a perpendiculer on the point C. of the groundline A B, which to do I open my compasse to a reasonable scantlet at a venture and make therewith two notes vz. D and E in the groundline A B. ech of a like distance from C. which done my compasse I open to a bigger widenes at a venture, and setting one foote in D. I make a circle or draw an arch aboue the line A B ouer the point C. likewise the compasse vnstirred and one foote placed in E. there draw another circle or arch crossing the first aboue C vz. in the point F. lastly drawing the line F C you haue your desire vz. F C perpendiculer to A B. and the angles F C B and F C A both right angles by the fift definition.

2. Conclusion.

To make a right angle another way and easier.

YOu shall draw a groundline videlizet A B then opening the compasse to any reasonable scantlet make thereon a semicircle vz. C E D. Now take this for a generall rule, and note it well, for it will stand you in great steade to many purposes, that any two lines meeting in the circumference of a circle issuing from the ends of his diametre do make a right angle, as in this figure any of the angles marked with E are right angles: it is demonstrated in Euclide lib. 3. propos. 30.



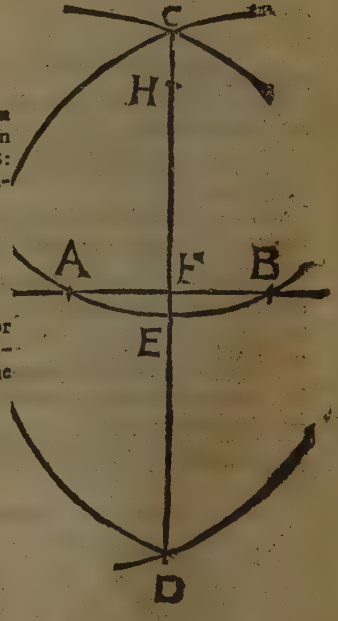
3 Conclusion.

To deuide any streight line or arch of a circle into two equall parts verie speedilie.

LEt there be proposed the line A B or the arch A E B to be equally diuided; vpon the extreames of either of these vz. A and B. I pitch my compasse opened to some ordinarie scantlet, and on those two centres A and B. I make two circles or arches crossing at C aboue A B and D below, then drawing the line C D, it shall equally diuide both the line A B in the point F, and the arch A E B in E.

4 Conclusion.

From a point proposed to draw a perpendiculer to any groundline.

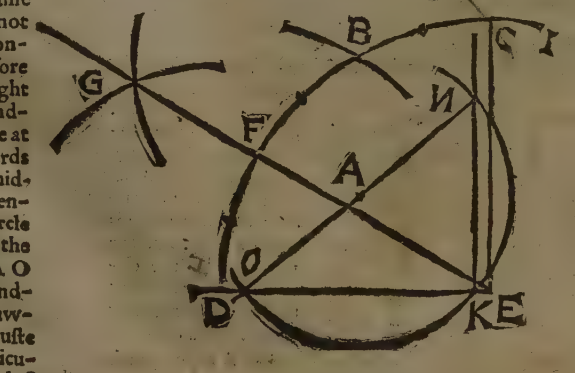


LEt H be the point proposed and A B the groundline, set one foote of your compasse in H and extend the other somwhat beyond the groundline vz. to E. and therewith on the centre H make the arch A E B, cutting the groundline A B in the points A and B: then making A and B centres, you shall by the 3. Conclusion deuide the line A B into equall parts in F: lastly drawing the line H F the same is your perpendiculer desired.

5 Conclusion.

From a point proposed to draw a perpendiculer to any groundline a redier way where the groundline lacketh length.

FOr example let there be proposed the plaine D E C whether it be a boorde, stone or plate, &c. and that from N being a point therein proposed, I would draw a perpendiculer to the groundline D E. Now because this perpendiculer will light so neere the point E being the extreame of this plaine, that I cannot worke it by the third conclusion, you shall therefore from D N draw a streight line crossing the groundline D E. by as any where at auenture somwhat towards D vz. in O, and on the middest of N O. vz. on the centre A, describe a semicircle towards E according to the semidiametre A N or A O which shal cut the groundline D E B in K, the drawing the line N K it muste needs be your perpendiculer desired by the 2. conclusion.



6 Concluſion.

From the extreame or end of a groundline to draw a perpendiculer verie eaſily where the ſame groundline cannot be extended.

IT happeneth often in making of quadrants and other geometricall operations that we are driuen euen from a very angle to erect a perpendiculer, either to make or trie the ſquare angle truely, as for example in this quadrant D E C. From K being the extreame of K D. I would erect a perpendiculer, here you ſee no roome left to worke by the firſt concluſion: Wherefore you ſhall open your compaſſe to any reaſonable ſcantlet whatſoeuer, and ſetting one foote in K extend the other within your figure where you thinke good vz. to A. and on the centre A according to the ſemediametre A K deſcribe a circle or a porcion bigger then a ſemicircle, & where this circle cutteth D K vz. at O thenſe lay a rule on A. and draw the line O A extending it ſelfe infinitely beyond A and it ſhall cut the ſaid circle on the otherſide in N. Laſtly draw the line N K and of neceſsitie it muſt be the perpendiculer deſired by the 2. concluſion.

7 Concluſion.

To do the ſame more redily another way with once opening of your compaſſe.

ADmit that vpon the extreame ot point E of the groundline D E. I would erect a perpendiculer which to do I open my compaſſe to any reaſonable ſcantlet and therewith on the centre E. I deſcribe an arch ſomwhat bigger then a quadrant vz H I. cutting the groundline A E in D. then on the centre D with the quantity D E. I make an arch croſsing H I in B. & on the centers D and B. the compaſſe ſtyll vnſtyrred, I drawe two other arches croſsing without the arche H I in G. then I draw the line G E which deuideth the arch D B in halfe, as well as the 3. concluſion vz. in F. Laſtly on the centre F (the compaſſe remaining at the firſt width vz. the width D E) I draw an arch croſsing the arch H I. beyond E in the point C. and ſo drawing a line from E to C the ſame is your perpendiculer deſired.

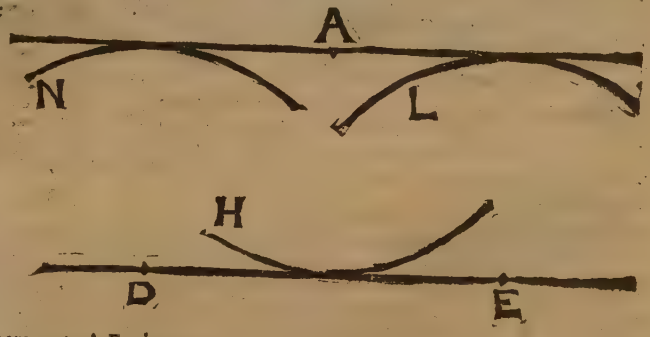
Note that the arch D F B C. is the iuſt quadrant of a circle deuided into three equal ſpaces by the points F and B. eche ſpace being 30. degrees ſuch as the quadrant D C is 90. euerie of which three ſpaces you may deuide in halfe as you deuided the arch D B. then will there be ſixe ſpaces ech 15. deg. thus may you with eaſe graduate a quadrant.

You may performe this concluſion another way thus. Erect a perpendiculer in ſome place of the groundline A E by the firſt concluſion vz. K L vnto which from the point E draw a line parallel by the 8. concluſion the ſame ſhall be the line C E your deſired perpendiculer. Thus you ſee how many wayes the Geometer can contriue one thing neither ſhall any draught ſo croſſe him but he can inuent ſome one way or other to performe his deſire. Theſe three laſt concluſions, eſpecially the firſt two of them I neuer read them in any booke, but in contriuing of deuiſes I haue beene driuen to caſt my wits to ſeeke them out, ſome will ſay to what purpoſe are ſo many wayes, one is as good as twentie: he is deceiued greatly, for at a time he ſhall finde that ſome one of theſe ſhall ſerue his torne when all the reſt ſhall do no good, as by examples I could here ſhew if it were materiall. Alſo there is a way by three quantities vz. 3. 4. and 5. making a triangle of them by the 9. concluſion the angle ſubtended by 5. ſhall be a right angle and diuerſe ſuch like.

8 Concluſion.

From a point propoſed to draw a line parallell to any line propoſed.

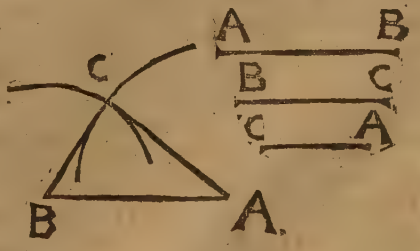
TO draw a line parallel to the line D E propoſed which ſhall cut the propoſed point A. ſet one foote of your compaſſe in A and open the other to ſuch width that it make an arch onely touching the line D E vz. the arch H. Then keeping the compaſſe at that width on two ſeuerall points taken at auenture in the line D E vz. D and E. make two ſeueral arches vz. L and N. then drawing a line which may be a toucheline to both thoſe arches the ſame ſhall cut the propoſed point A. and be parallel to the propoſed line D E as you heere ſee.



9 Concluſion.

To make a triangle of any three lines propoſed.

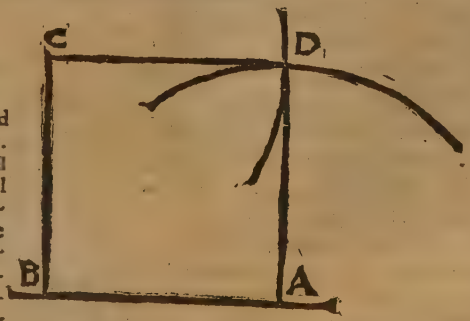
LEt A B. B C. and C A. be the three lines propoſed, firſt draw a line equall to any one of them, as to A B. then taking the quantitie of B C in your compaſſe, therewith vpon the point B of this ſecond line draw an arch, laſtly, take C A in your compaſſe, and making the other end A centre deſcribe another arch croſsing the firſt & where they croſſe ſet C. then drawing lines from C to A & B your triangle is made whereby you may gather, that except two of the lines propoſed be longer then the third, there can be no triangle made of them.



10 Concluſion.

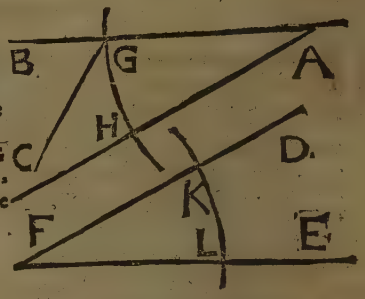
To make a ſquare of any ſide giuen.

LEt there be propoſed the ſide of a ſquare vz. A B. vpon the point B erect a perpẽdiculer equal to A B. by the 1. or 6. cõcluſion vz. B C. then take in your compaſſe the quãtitie A B or B C and making A & C centres, therwith make two Arches croſsing in D. laſtly drawing the lines D C and D A. Fiet.



11 Concluſion.

To make an angle equall to any angle propoſed.

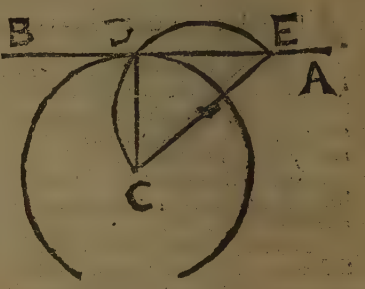


LEt there be propoſed the angle B A C. now opening my compaſſe at auenture & making A the centre, I draw an arch cutting the two lines containing the angle propoſed in the points G and H. Then my compaſſe remaining at the ſame width, I draw the like arch vpon the centre F wherein I ſet the ſpace K L equall to G H. laſtly drawing the lines D K F. and E L F. I haue the angle D F E. equall to the angle B A C. propoſed.

The ſame is to be done after another ſort: you may by drawing a third line as G C make the angle propoſed a triangle and then if by the 9 concluſion you make another triangle equall thereto, the ſame ſhall haue equall angles ech to his match to the other.

12 Concluſion.

To find the very point where a touchline toucheth any circle.

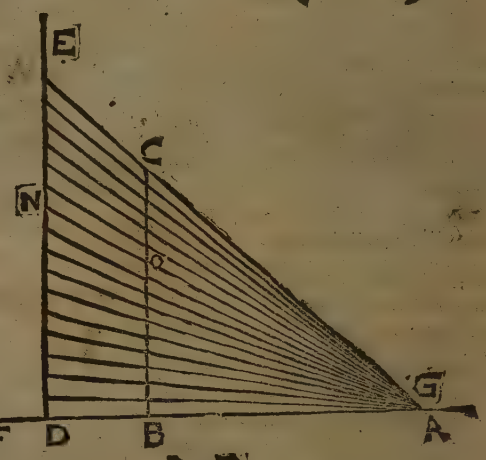


DRaw a line from any point of the touchline A B. vnto the centre of the circle vz. E C. and thereon make a ſemicircle vz. E D C. which ſhall cut the touchline and the circle in the very touch point vz. D, marke therefore the manifold vſe of the 2. concluſion.

13 Concluſion.

To diuide ſpeedily and exactly any line into many equall parts.

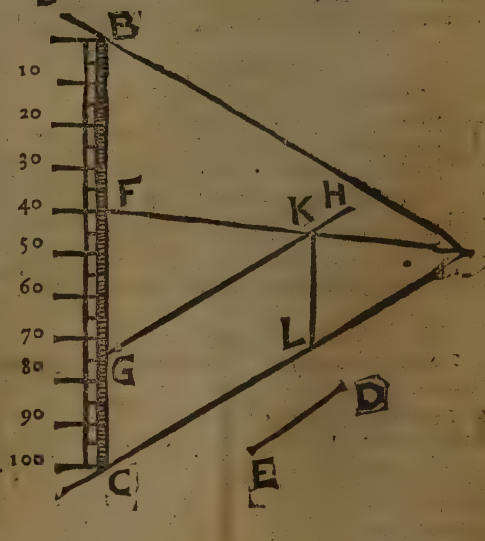
LEt there be a line propoſed vz. B C. to be deuided into 16. equall parts which to do, erect him on the groundline A F. perpendiculer or inclining all is one: Then draw another line vz. D E. parallel to B C. cutting A F. in D, this done open your compaſſe to a conuenient ſmall ſcantlet & therewith beginning from D. marke out 16. equall diuiſions in the line D E. ending in H. to which you may ſet numbers, then laying a rule on H and C. draw foorth the line E C. till it cut the groundline A F. in the point G. then laying a ruler on the point G. and euery of the 16. notes in the line D E. draw ſo manie ſtreight lines iſſuing from G. vz. 16. and they ſhall deuide the line B C. propoſed into 16. equall parts. But if you would haue B C. into 40. 60. 100. or more partes then ſhould you ſet D E. farther off.



14 Concluſion.

To prepare a triangle to be alwayes readie for deuiding of lines exactly into as many euen parts as shalbe required.

FIrſt make you a ſcale of as many equall parts as you thinke will beſt fit ſuch purpoſes as you pretend, an 100. equall parts ſerued me wel, and will ſerue you to deuide a line into any number of equall parts not exceeding 100. Then by the 9. concluſ. make a triangle of three equall ſides ſo that this ſcale be the baſe thereof as you ſee A B C. which I did make on a faire boord couered with parchment then hauing alwayes a rule with a centrehole towards the one end to ride vppon the point A. where muſt be a fine pinne or ſpaniſh needle erected fit to the hole: ſo haue you a verie neceſſarie inſtrument made to diuide lines yea of ſmall quantitie into as many equal parts as you liſt. as for example, in menſurations & plattings we vſe ſmal meaſures proportionable to the great. which ſome haue called the arte of litle foote: for which purpoſe I haue oftentimes diuided an ynch in 60. parts ſomtimes more ſomtimes leſſe as ſerued beſt my purpoſe, which I wil ſhew you heere to do though your ſcale be an hundred: let D E. be the quantitie of an ynch to be ſubdiuided into 60. parts. Now therefore I draw an obſcure line from A. to 60. parts of the ſcale vz. A F. then I appoint the quantitie C G. in the ſcale equall to D E. and from the point G. do I draw another obſcure line parallel to A C. by the 8. concluſion vz. G H. which cutteth the firſt obſcure line A F. in the point K. then drawing the line K L. by the ſaid 8. concluſion parallel alſo to B C. the ſame ſhalbe equall to D E. and ſtand readily placed in your triangle to be diuided into 60. equall parts like as in the 13. concluſion by laying the rule on A. & euery of the ſaid 60 parts. It were heere far beyond my preſent determination to ſhewe the infinite commodities of theſe two laſt figures as wel in ſhrinking and ſtretching of platformes and for manifold proportions Geometricall, as alſo in proſpectiue.

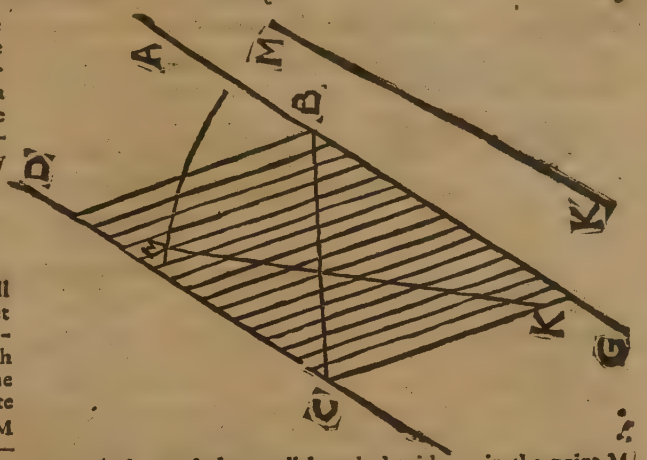


15 Concluſion.

Another ſpeedie way to diuide a line into many equall parts.

FOr example I will deuide the line B C. mentioned in the 13. concluſion into 16. equall parts another way, which to do wa Ird two long parallels vpon the extreames of B C. vz. A B G and D C E. then opening my compaſſe to a reaſonable ſcantlet

ſcantlet I marke out 16. equall parts in ech of thoſe parallels beginning from the extreames of B C. in the one vpwards, vz. from C to D. in the other downewards, vz. from B. to G. and ſo number them, which done I drawe 17. narrow parallels according to thoſe diuiſions croſsing the line B C. in 15. places and do diuide the line B C. into 16. equall partes as you may better ſee by this figure then by many words.



16 Concluſion.

The ſame a third way and redieſt.

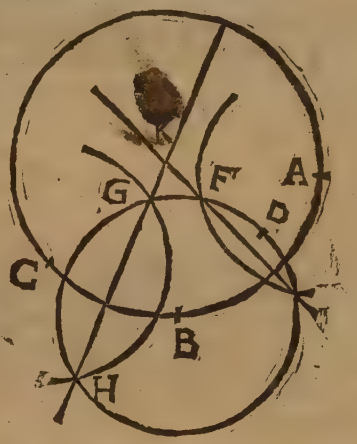
FOr this you muſt alwayes haue a table drawne full of parallel lines being all of equall ſpaces and ſet numbers vnto them, as for example by theſe 16. parallels reddie drawne, I wil diuide this line K M. which is longer then B C. into 12. equall parts, I take the quantitie thereof in my compaſſe & ſetting one foote in the loweſt K M parallel C G

vz. at K. with the other I make an arch amongſt the parallels which cutteth the parallel marked with 12. in the point M. then drawing the line K M. croſſe the parallels, the ſame is equall to this line K L. propoſed and diuided into 12. equal parts: and if you would haue K M. diuided into but three parts, recon euery 4. parallels for one, you haue your deſire.

17 Concluſion.

Any three prickes ſet downe howſoeuer, not being in a ſtreight line: how to deſcribe a circle that ſhall cutte them all three.

LEt A B C. be the three prickes propoſed you ſhall ſet the one foote of your compaſſe in the middlemoſt pricke vz. B. and extende the other towards the farthermoſt of the other two, ſomwhat more then halfe way be ſure as you ſee here B D. and therewith on the centre B. deſcribe a circle, then the compaſſe vnſtirred deſcribe two other circles on the centres A and C. that ech of them may cutte the former circle D. in two places vz. in E. and F. and in G. and H. laſtly drawing the lines E F. and G H. where they croſſe at K. there is the centre of the circle deſired, for ſetting one foote of your compaſſe in K. the other extended to any one of the three pricks A B. or C. and therewith deſcribing a circle on the centre K. it ſhall cut the reſt.



18 Concluſion.

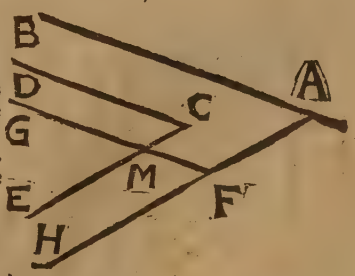
How to finde the centre of any circle or arch propoſed.

IF any circle or arch be propoſed make in the circumference thereof three prickes at auenture as heere you ſee A B. and C. and then by the 17. concluſion finding the centre of theſe three prickes, the ſame ſhalbe alſo the centre of your circle or arch ſought for.

19 Concluſion.

To make an angle equall to any angle aſsigned otherwiſe then in the 11. concluſ.

LEt B A H. be the angle aſsigned, then ſhall you draw the line C D. parallel to A B. and C E. parallel to A H. by the 8. concluſion and ſo ſhall you haue where the lines C D. and C E. do croſſe the angle D C E. equall to the angle B A H. aſsigned, as by the 11. concluſion you may make triall. Hereby you ſhal ground this generall rule which will ſtand you diuerſe times in ſteede if you marke it, that all angles whoſe containing ſides are parallel ech to his mach are equall ech to other, as here the angle G M E. is alſo equall to B A H. becauſe M G. is parallel to A B. and M E. to A H. and ſo is G F H. equall to B A H. the like is ſhewed by the line L K. of the 7. concluſion in making of a right angle. This dexteritie in contriuing angles is the grou nd of all menſuration and platting.



20 Concluſion.

To diuide eaſily a very ſmall circle into a number of equall diuiſions.

YOu ſhall about your ſmall circle deſcribe a very great circle concentricke therto, which great circle you may at pleaſure diuide into what partes you liſt with a paire of compaſſes and helpe of the 3. and 7. concluſion, which done you ſhal (by a rule laide from the common centre of theſe circles to euery part one after an other of your great circles) diuide thereby the ſmal into the like parts, not vnlike to the diuiding of the ſtreight line in the 13. concluſion

Wherefore

wherefore if you haue a large circle of two foote diametre alwayes reddie diuided into 360. equall parts, and another into $365\frac{1}{4}$ equall parts, the ſame ſhall ſtand you in great ſtead to diuide any circle of the *Iewel* or any other aſtronomicall inſtrument, be they neuer ſo ſmall.

Heere follow the principles and rudiments of Aſtronomy and Coſmographie with the vnderſtanding of euerie circle of the Spheare and their vocables.

What Coſmographie Geographie and Topographie are.

Chapter 1.

COſmographie is as much to ſay, as the deſcription of the world: as well his Aethereall part, as Elementall, and in this differeth from Geographie, bicauſe it diſtinguiſheth the earth by the celeſtiall circles only: and not by Hilles, Riuers and ſuch like.

Geographie is a certeine forme and imitation of the picture of the earth, and of his chiefeſt and knowen parts, and differeth from Coſmography, becauſe it diſtinguiſheth the earth by hilles, ryuers, ſeas, and other notable matters, not reſpecting the circles of the ſpheare.

Topographie called alſo Corographie, is the deſcribing of any particular place without relation to the whole, not leauing out the ſmalleſt contents thereof, as ports, townes, ſmall ryuers, buildings, houſes, towers, walles, &c.

Of the placing of the ſpheares and the diuiſion of the world.

Chapter 2.

THe world is diuided into two parts: vz. Elementall, and Aethereall. The Elementall is ſubiect to dayly alteration, and conteineth the 4. elements, the earth, water, ayre, and fire. The Aetheriall part, called of the Philoſophers *Quinta*

Essentia, doth compasse the elementall part with his Concauitie, and is an inuariable substance alwayes abiding: and containeth tenne speares one compasing in another spherically, as you see in this figure of those tenne speeres, the speere of the Moone, is placed next vs, compasing the speere of the fire. And next it, the speere of Mercury, and so forwards in order of Venus, the Sunne, Mars, Iuppiter, Saturne: Next these immediatly is the starrie firmament, then the Christallin heauen, called the ninth speere: lastly the 10. speere called *primum Mobile* doth comprehend them all: whatsoeuer is beyond is the habitacle of God and his elect: for their motions looke the ninth cap. This I say after the opinion of old writers though Copernicus hath ascribed another order.

What a sphere or Globe his axtree and poles are.

Chapter 3.

A Sphere or Globe, is a sollide bodie, contained in one Superficies or flatte: in the middest whereof there is a point called his centre, from which all lines drawne to the vttermost Superficies are equall and called his Semidimetientes or Semidiameters.

The axtree of a Sphere, is his Diametient about which he is mooued: or more plainely, it is a line imagined, pasing through his centre to his circumference, about which his motion is performed.

The poles of the world, are the two extreames of the axetree, being likewise two points imagined in the heauens: the one is called the North pole or pole Articke, and is alwayes (to vs that dwell on this side of thequinoctiall) aboue the horizon. The other called the South pole or pole Antarticke, and is alwayes to vs vnder the horizon as much as the other is aboue.

Of the six chiefe great circles of the Sphere.

Chapter 4.

THe *Horizon* called also in latin *Fenitor* is euery where the circle separating the vppermost halfe world or Hemisphere from the lowermost, or more plainely it is a great circle of the Sphere whereon from the verticall point directly ouerhead a plum line let downe standeth perpendiculer from his centre.

The Meridian circle of any place, passeth by the saide verticall point directly ouer head, and the Poles of the worlde: to which when the Sunne commeth, it maketh noone aboue the earth, and midnight vnder the earth.

The Aequinoctiall is a circle crosing square the meridian, and the axtree line, lying iust betweene the poles, in euery part equally distant from them both: and when the sunne commeth thereto which is twise euery yeare it causeth the day and the night to be equall in length through the whole world, and is called Aequinoctium.

The Zodiacke, diuideth the Aequinoctiall in the middest at Aries and Libra: and lieth byas vnto him $23\frac{1}{2}$. degrees, declining on ech side towards the poles: and hath in bredth 16. degrees after some writers: and after others but 12. but all the other circles of the Sphere haue no bredth.

The two Colures are two cyrcles crosing one another square at the poles the one pasing by ♈ and ♎ the other by ♋ and ♑ limitting the two Aequinoctiall and the two Solstitiall points of the Zodiacke.

Of the fower chiefe lesser circles of the Sphere.

Chapter 5.

THe Tropicke of Cancer is a circle parallel to the Aequinoctiall distant from him Northwards $23\frac{1}{2}$ degrees, his vse is onely to bound the Eclipticke greatest declination Northwards: to which when the sunne commeth, the day is at the longest in our Horizon, which dwell North from the Aequinoctiall, and the night at the shortest, and there the sunne beginneth to go backe againe, and there said to be in his sommer solstice.

The Tropicke of Capricone is the like circle bounding theclipticke Southwards: and when the sunne commeth there it maketh the shortest day and longest night, and there begins to go backe againe, I say backe againe in respect of the parallels and lengthening of the day, but in the Zodiacke he goeth on still direct and forwards euery day one degree, as hereafter shal more manifestly be vnderstood, and there also is the sunne said to be in our winter solstice.

The Articke and Antarticke circles commonly called the pole circles, are likewise parallel to thequinoctial and in euery part as farre distant from the poles as the Eclipticke declineth from thequinoctiall vz. $13\frac{1}{2}$ degrees, and are made by the reuolution of thecliptickes poles: and therefore may well be called pole circles.

Of the Zodiacke and his diuision into degrees and signes and their carecters.

Chapter 6.

VVHat the Zodiacke is, I haue shewed in the 4. Chapter, he hath in bredth 12. or 16. degrees as there is said: the line or circle diuiding this bredth in the middest quite round, leauing 6. or 8. degrees that is to say halfe the Zodiackes bredth on ech side, is called the Eclipt circircle, and is commonly vsed in writing for the zodiacke, this Eclipticke is diuided into 360. degrees as thequinoctiall is, but then those are parted into 12. vz. euery part being 30. degrees. By this meanes the whole bredth of the zodiacke is diuided into 12. signes, but after another sense vz. in respect of the longitudes of fixed starres, Comets and such like: the whole heauens are diuided into 12. signes by circles issuing from the poles of the zodiacke by euery 30. degrees of the Eclipticke, as hereafter shall be more manifest. The first signe of the zodiacke is called Aries and beginneth in the vernall intersection of theclipticke with thequinoctiall: the rest proceede in order, as followeth: contrarie to the motion of the first mouer, that is from the West towards the East: and these be their carecters whereby they are written and knowne. ♈ Aries ♉ Taurus ♊ Gemini ♋ Cancer ♌ Leo ♍ Virgo ♎ Libra ♏ Scorpio ♐ Sagittarius ♑ Capricornus ♒ Aquarius and ♓ Pisces. Theclipticke, thequinoctical & euerie other great circle of the Spheare is said to contain 360. degrees euery deg. 60. minutes, euerie minute 60. seconds, euery second 60. thirds, & so forwards to the tenthes.

The materiall figure of the circles of the Sphere before mentioned, you shall haue in the title page at the beginning.

A farther discourse of the circles of the Sphere.

Chapter 7.

THis figure heere being the picture of the material Sphere made for commoditie in vsyng doth not altogither agree with the Sphere celestiall. For heere you see the Horizon is set fixed on two pillers, the Sphere with his axtree and poles appointed

pointed moueable, to bend downe, or to be lift vp. to and from this fixed Horizon, according to the eleuation of the pole aboue the ſame. Where in trueth, the axtree and poles of the world, and Sphere celeſtiall, are fixed for euer in one ſelfe ſame place: and neuer moue, but all the whole Spheare and Spheares mooue about them. And it is the Horizon that altereth to them continually in euery countrie, which is ſpecially perceiued Northwards or Southwards. For why? a man cannot go Northwards or Southwards 60. miles but the Horizon altereth a degree of the poles eleuation, either higher or lower, as in the 12. Chapter following is more manifeſt. And wheras you ſee in this figure one meridian Mobile: which in the vſe of the material Sphere ſerueth the ſteede of al the Meridians and parallels commodiouſly as it is well knowne to him that vnderſtandeth the vſe of the material Sphere, but aſſure your ſelfe the number of the Meridians are infinite, agreeable to euery ſmalleſt diuerſitie of ſituation. For euery ſeueral countrie, Eaſt or Weſt, from other but 30. miles, hath a ſeuerall Meridian, diſtant halfe a degree from the other: and ſo round. And al the Meridians meete and croſſe at the two poles as the two Colures do, which are Meridians alſo to ſome country. But ſoft, my penne hath runne a little too large of theſe Meridians: for you can ſcarſe ſay that the Sphere hath any Meridian, becauſe it neuer ceaſeth turning: the Meridian circle alwayes cutteth the North & South being deriued of the latin word *Meridies*, in Engliſh the South. There is no one point of the Sphere tarrieth a minute in the South, but turneth continually rounde once euery day: wherefore the Meridians are onely appropriate to the Globe of the earth: which is fixed immoueable, and beginne from the Iles of Canaria, as in the 12. Chapter. Theſe Meridians are likewiſe appointed and imagined fixed in the heauens: and then are called *Circuli horarii*, hower circles. But thoſe ſelfeſame circles imagined & appointed in the Spheare turning dayly about with the Spheare, & all the Speeres celeſtial as is ſaid, are their circles of right aſcention, called in latin, *circuli aſcentionis recte* and begin from the vernal interſection of the ecliptike with the equinoctial: that is, from the beginning of Aries, proceeding towards ♋ and ſo round, and they ſerue to as great vſe, in limitting the obliquitie of the zodiack, and euery point of the heauens vniformely: as the Meridians ſerue in diſtinguiſhment of places on the earth. So that you ſee, thoſe circles, which the common ſort call Meridians, are of three ſorts: the firſt fixed as it were on the globe of the earth, and there called moſt aptly Meridians. The ſecond fixed in the heauens and there called hower circles, although they may there aptly ynough be called Meridians alſo but for diſtinction ſake: the third continually moueable with the celeſtiall Speeres: and there called circles of right aſcention: and all theſe haue one ſelfeſame axtree which by the figure of the *Iewel* you may partly perceiue.

Where as alſo there are in the figure of the materiall Sphere, before ſet to the 6. Chapter, ſpecially appointed but fiue parallel circles: as namely the equinoctiall, the two tropicks, and pole circles, I may compare it to a mappe of the world wherein they vſe to ſet downe but the chiefe cities, leauing out all ſmall townes and villages. For you muſt know, that the number of parallels are likewiſe as infinite as the Meridians to be thwact full from the equinoctiall to ech pole, and euery one ſeruing to as great vſe as any of thoſe fiue: as hereafter wilbe ſhewed in my bookes following. But yet in the Sphere, they are not aptly called parallels, but rather *circuli* or *parallelli declinationis*, that is circles or parallels of declination, for that their office is to ſhew the declination of the ſunne, Moone, or any ſtarre, planet, or point of the heauens from the equinoctiall, and are numbred from him towards either pole, there ending at 90. ſo that looke what parallel cutteth at any time the place of the ſunne, Moone, or any ſtarre, the ſame counted from the equinoctiall is called his declination: As for example, either tropicke is but the $23\frac{1}{2}$ parallel and the ſunne being there is ſaide to decline $23\frac{1}{2}$ degrees, either pole circle is but the $66\frac{1}{2}$ parallel, and ſo of the reſt, and euen as the ſunne glides euery day in the zodiacke one deg. forwards, ſo doth he thereby get euery day a new parallel whereby the dayes are lengthened and ſhortned, all which premiſes you may alſo perceiue by the figure of the *Iewel*.

Of other circles of the Sphere, changeable with euery horizon, as Azimuthes, Almicantares and ſuch like.

Chapter 8.

THe Meridians hower lines, and parallels mentioned in the laſt chapter, do alwayes keepe one ſelfeſame ſtate, courſe, and place, but there are yet other circles moueable with euery conſtitution of the Horizon: of which ſort are almicantares, Azimuthes, circles of poſition, circles of ſtation, generall horizons and ſuch like. But all theſe are not vnlike to the Meridians and parallels in forme and faſhion, ſauing they are applied to other purpoſes in their ſundrie vocations, as hereafter will appeare. What the Horizon is hath beene ſhewed in the 4. Chapter, but this much farther is to be noted, that whither the horizon be taken on the ſuperficies of the earth, or through the centre, there riſeth no difference in the riſing or ſetting of the ſtarres and planets, or in any other ſphericall practiſing, except it be in the moone, or ſome comets which are very neere vnto the earth, which is one moſt ſtrong reaſon that the earth is but as a point or pricke in reſpect of the higher ſpheres and firmament: as for example, the ſunne being in the Aequinoctium, is manifeſtly found to tarry 12. houres aboue the earth, and 12. houres vnder, whereas if the earth were not as a pricke in reſpect of the ſphere of the ſunne, he muſt needs ſhine at that time leſſe then 12. houres abque the earth, by ſo much time as twiſe the ſemidiametre of the earth (that is at riſing and ſetting) ſhould hinder him, which by experience is found nothing. Other proofes Geometricall there are, heere impertinent to my intention, and of the moſt would be little regarded: for hardly will they beleeue that a ſtarre (a planet ſtarre I meane) ſhould be 100. times as bigge as the whole earth: and much leſſe that euery ordinary ſtarre ſhould be ſo bigge as the whole earth. Therefore againe to my purpoſe: in euery horizon the point directly ouer heade, called in latine *punctus verticalis* is commonly called the Zenith: and the point oppoſite thereto, that is to ſay, below the earth vnderfoote as it were, called *Nadir*: or to define them more artificially, theſe two points vz. the Zenith, and *Nadir* are the poles of the horizon, being 90. degrees diſtant from euery part thereof, euen as is ſaid in the 4. the poles of the world are from the equinoctiall.

The Azimuthes called in latin *Circuli verticales*, verticall circles, *quia omnes tranſeunt per verticem*, are great circles of the Sphere, croſſing all at the Zenith deuiding the Horizon into 360. degrees, as the Meridians do the equinoctiall from the poles of the world, and are numbred from the eaſt point of the horizon, yet after ſome, the foure quarters are numbred by 90. ending in the north and ſouth points.

The Almicantarathes, called in latin *circuli altitudinum*, circles of alitude, are the very like to the parallels of the Sphere beginning from the Horizon, thenſe growing leſſe and leſſe to nothing at the Zenith, as the parallels do from the equinoctiall to either pole. Circles of ſtation are the very azimuthes as ſhall appeare in the third booke more at large. Circles of poſition are the like, but croſſing at the two ends of the meridian line of the Horizon, as in the third booke. General Horizons be not much vnlike to them, as hereafter ſhalbe ſhewed, and ſo of the reſt: all which will be wonderfull plaine on my *Iewel*, which hath certaine circles on the *Reete* performing the vſes of them all, onely by altering their location, much like a player that playeth many parts with onely chaunging his voice and habite.

Of

Of the motions of the Speere and all the tenne Spheres.

Chapter 9.

I Make this distinction betweene the words Sphere, and Speere: by the Sphere, I meane the materiall Sphere with all his appurtenances: or more plainely, the whole frame of the world, as wel his celestial as terrestriall parts, in latin called *Sphera*. By this word Speere I meane the sphere of any seuerall planet, starre or motion, in latin called *orbis*: and hath both a conuex and a concaue superficies: yet euery *orbis* is *Sphera*, but euery *Sphera* is not *orbis*. This noted, you shall vnderstand that the 10. Speere called *primum Mobile*, the first moouer, doeth continually whirle about the worlde, vppon the axtrees and poles of the world, euery 24. houres once rounde, without ceasing, being so appointed by God from the beginning: and all the heauens, and all the nine Speeres are as it were perforce rapt and caryed about therewith euery 24. houres, from the East to the West, and so to East againe, by the onely violence of the same tenth sphere, called *raptum primum Mobilis*. Now the most part, and especially the vnlearned, seeing this dayly motion in the sunne, do thinke that he goeth it of himselfe: whereas both he and all the other planets, starres, and Speeres go a quite contrarie course (but a farre slower pase) and are caried volens, nolens (as it were) this way: much like a man, who being in a long barge or gally, in a very swift tide or streame, may walke a softly pase, as farre as the barge will giue him leaue, against the streame and tide, but the streame and tide being very swifte and especially if the winde helpe withall, may happen to carrie him a mile backe, before hee can walke the length of the barge forwards: or like as a Spider, that should creepe about a wheele contrary to that way which the wheele is driuen: Euen so the sunne of his owne motion, goeth euery day in the zodiacke, one degree forwards (that is) from the West towards the East, according to the sequele of the signes: yet, because his course is as it were against streame, winde, and tide (that is to say) against the motion of the tenth Speere, he is caryed quite contrarie to his owne motion, by the *raptum primi Mobilis*, from East towards West round about the world euery 24. howers which is done 360. times ere he can performe his owne course, that is in a yeare, euen as a man may driue a wheele 360. times about, before the spider can get once about the contrary way. This course of the sunne in the zodiacke is the cause of the diuersitie of the times of the yeare, of sommer, winter, spring, and haruest, long dayes and short. In the very like manner the course of all the other planets and starres in their Speeres, is quite contrary to the dayly motion of the first moouer, and euery of their Speeres hath a seuerall motion, one slower then other, the highest Speeres and neerest to the *primum mobile* haue slowest motions (as in the next Chapter is shewed) and the farther off, neere to the earth, the swifter. And some Philosophers holde opinion, that were it not that the violent swiftnesse of the *primum mobile*, were somwhat qualified and holden backe as it were, by the slow motions of the highermost Speeres, as the 9. the 8. the Speeres of Saturne, Iupiter, and Mars, and so with the helpe of the rest, that nothing could liue vnder it, but the violence thereof would destroy euery thing.

In what time euery Speere and planet finisheth his course and of the carrecters of the planets.

Chapter 10.

THe Cristalline or ninth speere his motion is almost vnsensible, requiring 49000. yeares to performe his course once about, contrarie to the first moouer, according to Alphonsus: but by Ptolome. 36000. yeares. The 8. speere, being the starry firmament, performeth his motion contrarie to the *primum mobile* in 7000. yeares once about the zodiacke.

The 7. speere, which carieth the starre or planet called Saturne (for all the fixed starres are in the 8. speere, the other speeres haue but eche one starre) accomplisheth his course once about the zodiacke in 29. yeares 162. dayes, and 12. houres.

The sixt speere of Iupiter, in 11. yeares 113. dayes and 20. houres.

The fift Speere of Mars in one yeare 321. dayes and 23. houres almost.

The 4. Speere of the sunne, in 365. dayes and sixe houres almost.

The thirde Speere of Venus in 584. dayes and $\frac{1}{16}$ of a day.

The 2. of Mercury in 365. dayes and 6. houres.

The 1. of the Moone in 29. $\frac{1}{2}$ dayes.

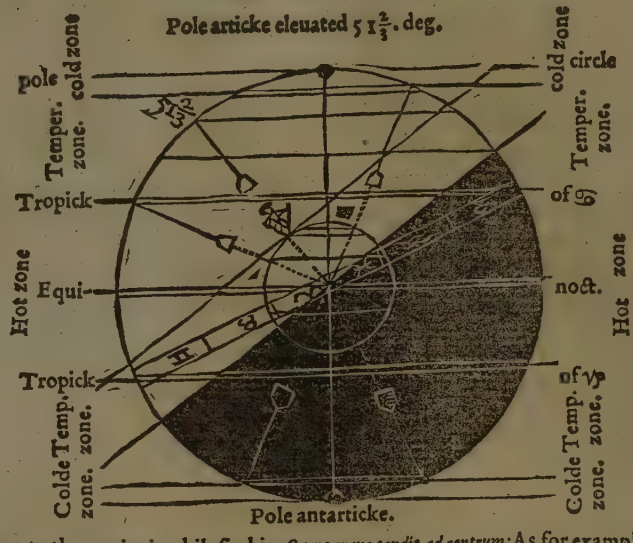
These are the carrecters of the planets ♄ Saturne, ♃ Iupiter, ♂ Mars, ☉ Son, ♀ Venus, ☿ Mercury, ☾ the Moone, ☊ caput Draconis, ☋ cauda Draconis, ☌ coniunction, ☍ opposition, □ quartile, △ tryne, ✶ sextile.

There is no place heere to proceede any farther about the theoricall motions of the planets, yet if it please God to giue me leasure a little to recouer that time which hath beene hitherto bereft me by meanes of those horrible and vnconscionable hunters of mens titles with concealements: I meane before I end this booke to set the Vranicall instruments or theorikes of the sunne and moone, with apt explanations of them, because they will be the greatest helpe that may be, to get the longitudes of Regions. In the meane season know thus much, that as I haue shewed in the last chapter, all the seuen planets by their owne motions contrarie to the 10. Speere, do continually go about vnder the zodiacke lying one within another within the zodiacke like a number of hoopes which a cooper carieth at his backe, and do neuer so much as peepe without the zodiacke on any side, but walke vnder it as vnder a bower or canapie. The sunne he neuer goeth one iote a wry, but alwayes keepes in the ecliptick line: All the other planets their speeres lie by as crosse the ecliptick, which causeth them to go reeling like a dronken man, sometimes on one side of the ecliptick & sometimes on the other, which reeling is cause of their latitude, but they neuer go from vnder some part of the zodiack: they neuer reele aboue halfe the bredth thereof: for to that end the zodiacke hath his bredth appointed him to keepe them within compasse, as to them that vnderstand the theoricks is wel knowne. Further the two points where the sphere of any planet doth cut the ecliptick, are called Caput and Cauda Draconis, as in the second Booke 5. 8. Chapt. you may reede: marke these two last Chapters well, and reade them againe, I haue set them downe as plainely as I can because these things in Astronomy I could hardly conceiue when I first began.

Of Zones, Climats, parallels and meridians.

Chapter 11.

COsmographers minding to limite out the earth, finding by most assured proofe (aswell by the eclipse of the moone, as other philosophical approbations) that the earth togither with the water maketh a round globe, & is placed in the midst & centre of the heauens, did therfore imagine & appoint thereon the like circles to the circles of the sphere, in euery respect Symmetrially agreeing vnto them as this figure sheweth, where I haue made the Globe of the earth farre within the sphere, so that what proportion the circles of the sphere beare one to another, the same do the like circles made on the globe of the earth beare one to another, insomuch that looke what parallel circle any place is scituate in on the earth: the same circle in the sphere doth touch the zenith of the same place. For you must note that all plum lines round about the world do hang to the



centre of the earth, according to the maxim in philosophie, *Omne graue tendit ad centrum:* As for example, to them that dwel in the tropick circle on the earth, the tropick circle of the speere toucheth their zenith, so that when the sun commeth to that tropick it standeth that day at noone iust ouer their heads. In like manner because heere at reading the latitude is 51 2/3 I say that we dwell in the 51 2/3 parallel of the earth and that the 51 2/3 parallel of the heauens (alwayes reconing them from thequinoctial) doth touch our zenith as in this figure you see: Now because the sunne neuer goeth farther then the tropicks on any side of thequinoctiall which are but the 23 1/2 parallels. I subduct 23 1/2 out of 51 2/3 there resteth 28 1/6 therefore I say that the sunne when she is at the neareste to vs commeth not at noone to our zenith by 28 1/6 degrees. But these circles being drawne on the globe of the earth, haue contrarie names and deffinitions from those of the sphere, and are by Cosmographers appointed to distinguish the earth as followeth: They haue appointed fiue zones in the heauens, of which two lie betweene the pole circles and the poles being horible cold and scarse habitable vnder them: a third lieth betweene the two tropicks and is extreme hotte, and scarse habitable because of heate: the other two are very temperate and habitable, and lye betweene the pole circles and the tropickes and in one of them dwell we. These zones on the globe of the earth are called plagues.

The parallels in Cosmographie are onely those paralels of the sphere that are so farre distant from other, that passing by the zenith of any horizon they alter the length of the day a quarter of an houre, and thequinoctiall it selfe is accounted for the first parallel they are vsual 21. on ech side of thequinoctial. The climates are such of the parallels as do alter the length of the day halfe an houre, beginning from the 4. of the Cosmegraphicall parallels, and are 9. in number on ech side of thequinoctiall, and haue seueral names of such places of the world as they passe ouer: as Dia Meroes, Dia Syenes Dia Alexandrias Dia Rhodon Dia Rhomes Dia Ponton Dia Boristhenes Dia Ripheos Dia Daniam: the other on the Southside of thequinoctial are called Ante Dia Meroes Ante Dia Syenes &c. As for meridians there is said sufficient of them in the 7. Chapter, they are circles cutting thequinoctiall square, and meeting altogither in the poles and serue to distinguish the longitudes of places by degrees of thequinoctiall.

Of the longitudes and latitudes of places.

Chapter 12.

THe longitude of a place is the arch of thequinoctiall, comprehended betweene the meridian passing by the yles of Canaria, and the meridian of the same place, and altereth by going full East or VVest from any place in euery 60. miles a degree: for Cosmographers haue appointed the first degree of longitude to beginne in those yles called *Insulæ fortunatæ* reconing the degrees from thense Eastwards, and so round thither againe. I say 60. miles to a degree, but that onely is vnder thequinoctiall, but in euery other parallel, the more he groweth towards the pole the fewer miles make a degree of longitude, as hereafter in my booke of Cosmography.

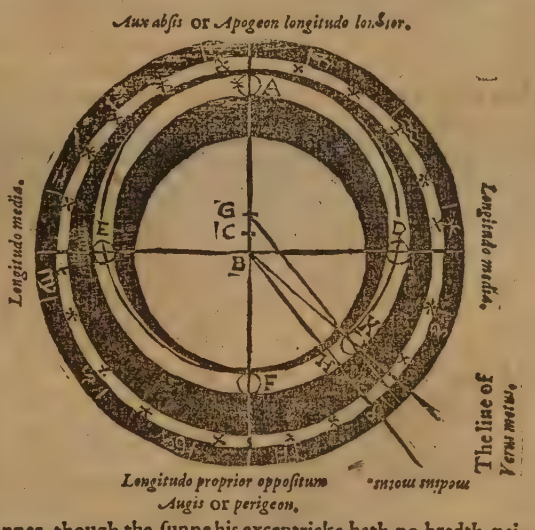
The latitude of a place is the parallel wherein the place standeth reconed from thequinoctiall: but according to Cosmographers definition, the latitude of a place is the arch of the meridian of any place betweene the zenith and thequinoctiall, or rather the arch of the meridian of any place betweene thequinoctiall and the parallel which toucheth the zenith, and is alwayes equall to the eleuation of the pole aboue the horizon. The latitude altereth by going Northwards or southwards in euery 60. miles a degree. Further you shall vnderstand all places being situate in, or vnder one parallel round about the earth haue one latitude, and for that cause they are commonly said to haue one horizon (though indeede they haue diuerse) and in truth one situation of the horizon my *Iewel* serueth thē all as hereafter shalbe shewed: the reason is because the sun doth both rise and set at like houres in one of those places as in another, and likewise the planets and starres. Yet as much as any countrie is distant from another in any one parallel by degrees of longitude, so much distance of time is there betweene the rising and setting of the sunne, moone or starres, in euery such perticuler place for euery 15. degree of longitude an houre, as for example: there is a famous citie in high Germany called Moguntia commonly Mentz, where printing was first deuised by one *Iohannes fauſtus* anno 1453. whose latitude is 50. degrees 10. minutes, not full equall with ours, and therefore lieth not altogither in the same parallel, it lacketh one degree and 30. minutes, yet neare ynough for this example except the difference were more: the longitude of that Citie is 25. degrees 4. minutes, and the longitudē of our towne of Reading is about 13. degres. Now because the longitude of Moguntia is greater then of Reading I know that it lieth more East by as much as 25 4/60 exceedeth 13. which is 12. degrees 4. min. & therefore the sunne must needs rise 12. degrees there before he riseth at Reading, that is 4/5 of an houre, or more plainer three quarters of an houre and 3. minutes and little better, for euery houre is 15. degrees of thequinoctial & euery 4. minutes of an houre is one deg. yet for all this doth the sunne rise at the same houre there as he

as he doth here according to computation, becauſe the houres are al rekoned by noone, that is from the ſuns comming to the meridian, for who doubteth when it is noone heere aboue the earth, but that it is midnight vnder the earth and ſo contrariwiſe. Likewiſe when it is noone here, then to them that dwell in the VVeſt from vs, and iuſt in the ſame parallel that we do: it is ſunne riſing, and ſo when it is noone to them it is ſun ſet with vs. and therefore it cannot be noone there and heere altogither for it is neuer noone in any place vntill the ſunne come to the meridian of the ſame place that it ſtand full South vnto them.

Chapter 13.

Of the theorickes of the planets.

IHaue ſhewed before in the 2. Chap. that all the 7. planets haue their ſeuerall ſpeeres one vnder and within another: and in the end of the 9. Chapt. that their walke or proper motion lyeth continually vnder the Zodiacke in length and bredth. And now perhaps you would thinke that their walke, circuite or motion ſhould be performed about one centre vz. concentricke to the earth, as the zodiacke is, which is farre otherwiſe: For there is none of the planets which mooueth on the centre of the earth, but euery of them hath a ſeuerall centre farre and diuerſlie diſtant from it: which excentricitie is the cauſe of great toyle in ſeeking and making rules, tables, and ephemerides for the places of the planets: and alſo of fayning and imagining of diuerſe circles, epicicles and hypotheſes, to bring thoſe irreguler motions vnto ſome certaintie: Inſomuch that of late yeares that ſinguler man Copernicus affirmeth that the ſunne is the fixed centre of the world, about whom the earth moueth (not the ſunne about the earth) and that all the reſt of the planets moue regularly about the centre of the ſunne ſauing the moone which like an epicicle moueth about the earth in the ſpeere of the earth 13. times in his yearely motion. But omitting the inuentions of Copernicus, and a number of the reſt, I will only heere ſhew a figure out of thoſe which haue alwayes bene before his time moſt in vſe to the end that you may the better vnderſtande diuerſe matters in my booke following. VVherefore Saturne being the highermoſt planet, I will proceede with his frame or theoricke repreſented by this figure following: wherein the vttermoſt ſpace or ſpeere is the zodiacke of the 9. ſpeere, the next is the 8. ſpeere or ſtarrie firmament, immediately vnder it is the frame or theoricke of Saturne conteining three orbes or ſpeeres, the two blacke ſpeeres are called *Deferentes Apogeon* or *Deferentes excentricum*, that is to ſay cariers of the Apogeon and excentricke: the white midlemoſt ſhut in betweene them is called the excentricke, or Deferens epyciclum becauſe the epicicle carying the ſtarre of ♄ is carried therein. The Apogeon of ♄ is in theſe dayes about 13. $\frac{1}{2}$ of ♐ thorough which D E a line drawne from the centre of the earth vz. B. and appointing the centre of the epycicle vz. A in the ſame line: diuide A B into 80. parts, 4. of thoſe and 20. minutes ſhalbe the ſpace C B. and vpon the centre C. is the excentrike deſcribed, whereby you may well conceiue that when ♄ is in A, then is the centre of his epicicle farther off from B. the cẽtre of the world, then when he is in F by the quantitie of the excentricitie vz. C B, & is then ſaid to be in his Appogeon aux or Abſis and longitudo Longior, that is fartheſt from the earth. In F. he is in *oppoſito augis*, or *perigeon* and *longitudo proprior*, that is neareſt the earth. In D & E, he is in *Longitudine media*, that is in the midde way betweene the Apogeon and Perigeon: that is to ſay nearer to B then A. and farther off then F. the prickt circle in the excentricke is called the equants diſcribed on the centre G. as farre diſtant from C, as C is from B. whoſe office is to regulate the irreguler motion of the epicicles centre in his excentricke: and whereſoeuer the epicicle be a line drawen from the centre B. to the zodiack parallel to a line drawne from G. the equants cẽtre thorough the epicicles centre, the ſame line as B H. is called the line of *medius motus* and the degree in the zodiacke pointed thereby is called *medius motus* but by a line from B. the centre of the earth through the epicicles, centre is alwayes ſhewed *verus motus*. Further the bodie of the planet in reſpect of the epicicle is but a point & is carryed about on the epicicles circumference which cauſeth him to be direct, ſtationary, and retrograde: the epicicle alſo hath his Apogeon and Perigeon. A number of other matters there be about theſe theorickes which heere I neede not mention, as *Equacomus* arguments, proportionall minutes, and ſuch like: becauſe my purpoſe is heere but to giue a taſt, that you may not be ſtalled when any of theſe tearmes come in queſtion. VVherefore it ſhalbe ſufficient for you to know that all the reſt of the planets haue the like frame or theorickes in manner, though the ſunne his excentricke hath no bredth, neither hath he an epicicle: Mercurie he hath ſomwhat more to do by reaſon of his *Circulus paruus* and ſo of the reſt, ſome difference they haue ech of them: their excentricities and Apogeon alſo do all differ from other.



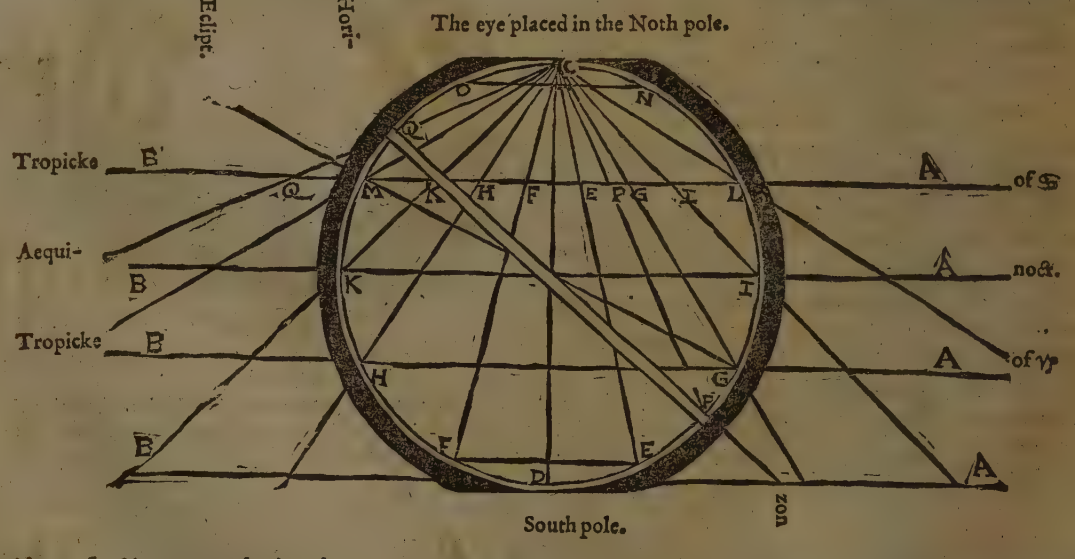
The ſeconde booke of the Mathematicall *Jewel*: compiled by Iohn Blagraue of Reading, Gent. *ſhewing the compoſition and making of the Jewel: being a moſt neceſſarie and profitable worke for all thoſe to be well ſeene in, which ſhall indeuour to deſcribe mappes or ſea cards, or to proiect artificially the globe or any part thereof into a plaine or platforme, as exact and perfite for any purpoſe as the globe it ſelfe.*

Secondly it conteineth the inuention, definition and explanation of this Iewel, *and of* euery circle and thing therein contained with their vocables and names, moſt neceſſarie to be foreknowne.

Chapter 1.

A neceſſarie diſcourſe which Gemma Friſius vſed as a preamble to his Booke, De Aſtrolabio Catholico by what reaſon the globe is brought into a flat or plaine forme.

BEcauſe ſaith he the making of a Sphere or globe is verie chargeable with his furniture and thereto requireth moſt exquiſite workemen, notwithſtanding cannot be made in all points without ſome errors, the vſe thereof to trauilers comberſome becauſe of caryage, hardlie kept and maintained from hurt, and being once blemiſhed or hurt not eaſily ſalued: for theſe & diuerſe other cauſes, ingenious perſons vſed long ſince great indeuour to reduce the globe with his circles into a plaine forme. But ſeing (as it is well knowne to the meaneſt geometricians) that a flat ſuperficies cannot be equally anſwerable to a globes Superficies in all points (nay ſcant in any point) for that there is no affinitie or proportion of a ſtreight line to a crooked, nor of a globe to a plaine: therefore there reſted no other meane to bring this purpoſe to effect but onely by the art Opticke, commonly called Proſpectiue: By which Arte artificiall painters vſe on plaine tables to ſet forth buildings or any thing elſe in the ſame ſhew of proportion, as it appeareth to the eye in all reſpects. Of which Art Albertus Durerus, a famous painter and Mathematician ſhewed two ſpecial and excellent reaſons; whereof the one and chiefeſt was thus: to place a plaine and cleare glaſſe ſet betweene the eye and the thing ſeene or obiect: And



ſo (the eye fixed in one very place) to draw vpon the glaſſe whatſoeuer he ſaw through the ſame. Now in trueth there is no way ſo apt, ſo proportionable and commodious, to bring the Globe or any thing that hath thickneſſe into a plaine flatte, but onely by proſpectiue lineaments, like to thoſe which the eye by imagination maketh on the glaſſe ſet betweene the eye and the thing ſeene. By this very Arte diuerſe men haue diuerſe wayes ſought to bring the globe in plaine: whereof the beſt & moſt commodious that euer was before this, was that of which Iohannes Stophlerus ſet foorth the making and vſe, although it be thought that he was not the firſt inuentor thereof. Touching the making whereof, he vſeth a long diſcourſe: whereas in ſhort it is but thus. Deſcribe a meridian circle, and place the eye at one of the poles vz. in C, and let any of the lines marked with A B. be your plaine glaſſe: marke where the lines iſſuing from C do cut your plaine A B. as in this firſt figure, for they doe limitte thereon the diametres of ſuch circles of the globe, as they comprehend betweene any two lines. This done draw any of the lines A B ſeuerally by himſelfe, whereon make all the notes there had. Theſe ſerue you for the dyametres of euery ſeuerall circle of the aſtrolabe, as in this ſecond figure appeareth. And thus haue you the manner of the drawing of the chief circle, of that noble inſtrument, a ſpeedier way then Stophler teacheth, which he either ouer ſlipt or ſaw not. But for the Almicantares and Azimuthes and other particularities to euery ſeuerall eleuation, it is no place heere to ſhew.

Beholde

Behold the lineaments of Stophlers aſtrolabe taken out of the former figure, wherein the centre repreſenteth the North pole.

E F. The pole circle.

G H. The Tropicke of ♑

I K. The Equinoctiall.

L M. The Tropicke of ♈ which is alwayes in that aſtrolabe the innermoſt circle of the limbe.

L H. Is the ☽odiacke, and is made to moue on the centre.

P ☌. Is the horizon, whoſe part without the limbe is neuer vſed.

In verie like manner the plaine ſphere which this booke treateth of, is diſcribed, ſauing that the circle here is the Colurus Aequinoctiorum, which there is the meridian. His dyametres diuided, the one vz. A B, being the equinoctiall, the other vz. C D the axtree line. The eye is heere twiſe placed firſt in one of the poles as before: and againe in one of the interſections of the equinoctiall with the colure. From the eye in the pole vz. M A, is the equinoctiall line C D. diuided into 180. degrees, or parts by directing lines from the eye M A. to euery degree of the ſemicircle C B D againſt it. From the other eye in the ſaid interſection vz. in C, is the axtree line A B diuided likewiſe into 180. parts, by proiecting lines thence to euery degree of the ſemicircle A D B. lying againſt it. This done to make the meridians, you muſt ſeeke a centre for euery three prickes, of which, two muſt alwayes be the two poles vz. A B. the thirde, ſome one of the diuiſions

or parts of the equinoctiall line, thereby drawing the arch from your purpoſe as in this figure you ſee ſome drawne. To make the parallels, ſeeke the centre of euery three pricks, whereof two muſt alwayes be taken in the colure A C B D equal diſtant on ech ſide of one of the poles as here you ſee E. F from the pole B. the thirde amongſt the parts of the axtree line of like diſtance from the ſame pole as you ſee G. and thus draw ſo many meridians and parallels as are parts in A B, and C D as by the lineaments within the blacke limbe of this figure, & by other figures following in this ſecond booke you ſhall more plainely ſee.

Theſe inſtructions did Gemma Friſius ſet downe for making his Catholicon Aſtrolabe & bids you to put to a rule, a Curſor and Brachiolum, and on the other ſide of the ſame plate (for he appointed to haue one or two ſeuerall plates loſe in the *Mater* like Stopler) willeth to place the theoricke of the ſunne, the kalender with the geometricall quadrat: and on the backſide of the inſtrument to haue generall horizons after Stophlers inuention, with Stophlers *Reete* and rule and ſo endeth. But I meane to haue but one plate in all, and none of all the other tackling but the kalender: and hope by the grace of God to make a perfecter inſtrument then yet euer was any: ſuch a one as you ſhall thinke worthie to be called a *Iewel* ſeruing generally through the whole world from pole to pole, which Stophlers could neuer doe, nor Gemma Friſius in all points.

Chapter 2.

What materiall this Iewel *were beſt to be made of.*

THis *Iewel* conſiſteth but of two plates, the one lydging and called the *Mater*, the other mouing thereon called the *Reete*. VVherefore for your *mater* if you will haue your *Iewel* in mettall and take no great paines in working, you may prepare a plate of pure tynne, and tynne glaſſe, of ech like quantitie melted together, and it will be ſtiffe, and looke faire like ſiluer almoſt: otherwiſe get faire new lattyn braſſe ſomewhat thicke for it is a great fault if your *Iewel* be too light in taking altitudes, becauſe euery ſmall winde will ſtirre him and other cauſes alſo. Or if you will go to the coſt ſiluer is beſt, and farre eaſier to worke then braſſe, I haue tried them al and made aſtrolabes of euery of thoſe mettals

tals with my owne hands. And for a shift a faire pastborde pasted on a massie borde, will serue a young practitioner.

Then for the *Reete* it is best to be of the same mettal the *mater* is of, but as thinne as may be. A very plaine and cleere lantornes horne (were it not that it will cast with heate and moisture of the aire) had no fellow, which I once vsed as a great treasure vntill I at the last diuised artificially to cut out the *Reete* as hereafter I will shew. And to be short but for a mans fancy and feare of hurting when it shall come in children or fooles handling, there can be no way more delicate then to make the *Iewel* of pastbord, because the circles may be so liuely distinguished with coloured ynkes, and the *Reete* so easily and exactly cut out. And no doubt being glewed and fastned to the bottome of a shallow box made for the purpose of bone, or some massie woode, as Brasil, Lignum vitæ or Boxe, will there be kept safe many yeares from bruising, soyling, wet and such like. And he that will be ruled by me let him first make one of these ere he proceede to worke in mettall, and let him make his pastboord of pure good paper himselfe.

Chapter 3.

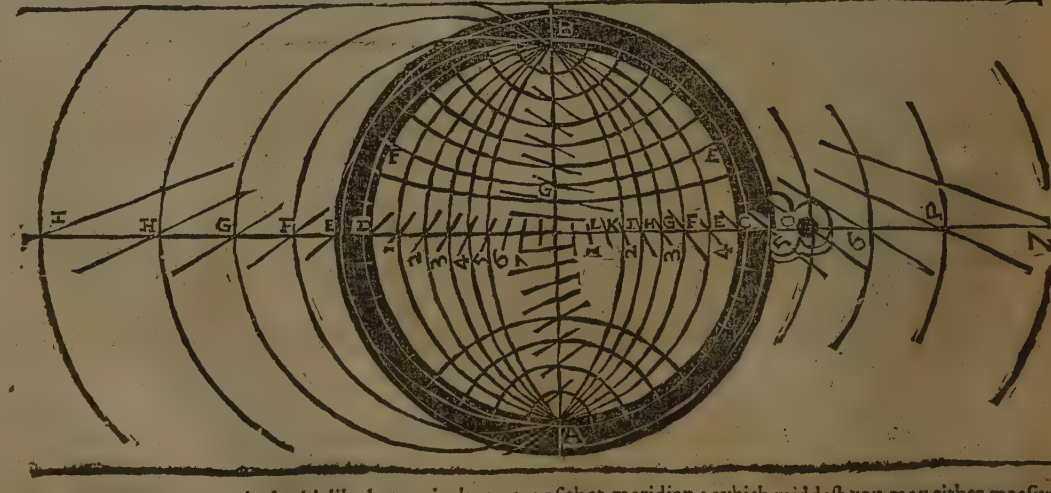
The meridians and parallels drawne how to finish the Mater.

THe *Mater* of my *Iewel* is nothing different from that of G. Fris. as by the great figure you may see, but be your *Iewel* neuer so little, let the meridians and parallels not be aboue two degrees betweene, as in my great figure they are, and being aboue 8. ynches diametre but one degree, for euer the more circles the better and more effectuall to euery action. VVell then your meridians and parallels so drawne as Gemma Frisius hath taught, then would I haue euery third distinguished with a greater stroke, or euery fift if you make them but one a peece. Thē let euery 15. meridian be seuered with prickes al a long their arches: likewise let the $23\frac{1}{2}$ parallel on ech side of the quinoctiall, which are the tropickes: also the $23\frac{1}{2}$ parallel next either pole, which are the pole circles, togither with the two diamet. be prickt, which with the ecliptick line drawne byas betweene the two opposite ends of the tropickes, as you see, doe liuely represent vnto you all the chiefe circles of the Sphere, euen as though you had the Sphere or globe in your hand. To the said prickt houre lines, you must set figures the axtree line being 6. of clocke at morning and euining the outermost meridian at C next the handle 12. at noone, and the same meridian at D. 12. at night, and so the rest but in very small instruments: these figures might be placed on the rule which applied to the quinoctiall line at all times supplieth the turne. So likewise vnto the ecliptike line let the carecters of the signes be ascribed vz. ♈ and ♎ to beginne at the centre ♋ at the end next the handle, which end must lye $23\frac{1}{2}$ degrees from the quinoctial towards the North pole as you see, and ♑ to beginne at the other ende, the rest in order. These carecters in small instruments may be also supplied in the rule: So much for the *Mater*. As for the numbers of the limbe, let them be written as in the great figure of this work you see done.

Chapter 4.

How to finde the centres of the meridians three seuerall wayes.

AS for the limbe of my *Iewel* it is easily to be diuided by my 1. Booke 20 conclusion into 360. degrees, but forasmuch as Gemma Frisius saith, that it is an easie matter to finde the centre of three prickes and so passeth away: he spake belike to Geometricians, for it is not so easie to him that neuer read the 5. proposition of the 4. Booke of Euclide or the like: well, let that be one way: my 15. Conclusion will instruct you therein. A second way is thus: you shall infinitly extend or draw forth the diametre C D, on either side: then to discribe all the meridians betweene C. and the centre of the *Iewel*, you shall first diuide the extension of that dyametrall line beyond D. by laying a ruler on the point A. directing the other ende from degree to degree of the quadrant A D. or from 2. degrees to 2. deg. euen in the verie same manner as you diuided the diametre C D. by the semicircle C H D. which diuisions in the saide line I haue marked with E F G H I K L &c. beginning from D. then for your better helpe I note all the diuisions of the line C D. betweene C. and the centre with the same letters E F G H I K L &c. beginning from C. And now the iust middle be-



weene any two notes marked with like letters, is the centre of that meridian: which middest you may either measure out with your compasse, or finde by the 3. Concluſ. As for example: in this figure pitch your compasse in the iust midst betweene H and H. and there doubtlesse is the centre of the meridian A H B. So likewise iust betweene K and K is the centre for the meridian A K B. and so of the rest. In the very like manner to make the other halfe of the meridians, you may diuide the other part of the diametrall line extended beyond C from A, by the degrees of the quadrant A C,

A C, and worke in all points as before, but in this figure I haue reſerued it to ſhew my third way becauſe I would ſaue a ſtampe. Note that theſe circles E F G H I K &c. ſtanding whole round as here they do, are the very ſelfeſame circles which are called generall horizons after Stophlers inuention, and are neuer aboue 90.

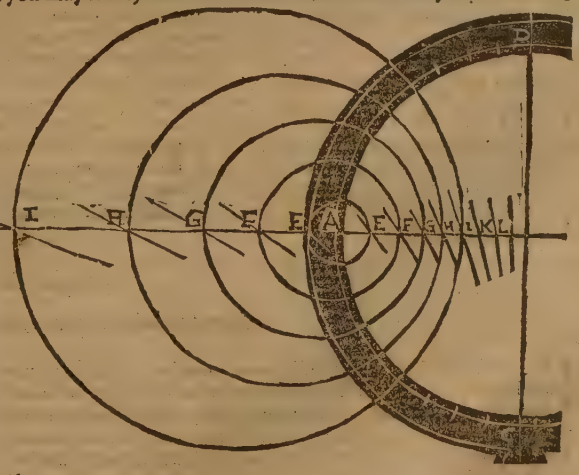
The thirde way to finde the centres of the meridians is the beſt and eaſieſt and therefore I alwayes vſed it, but except euery pricke and lineament before drawne be paſsing preciſely done, it is the worſt: for the bredth of a centre pricke loſt in ſome one place will bring you out 2. or 3. ynches in another, yet by this meanes you may know the better to examine your worke. VVell, then to deſcribe the other halfe of the meridians next D, by this third way, you ſhal find of my poore credite, that euery ſeconde note of the line C D, betweene C and the centre, is a centre to one or other of the notes betweene D and the centre. VVherefore for breuities ſake I ſet figures to all the notes of the line C D. betweene D and the centre vz. 1 2 3 4 5 6 7 8. beginning from D. Likewiſe I ſet the ſame figures to euery ſecond note in the other halfe of the ſame diametre, beginning from the centre of which the note 1. is the true centre to the arch A 1 B. and the note 2. to the arch A 2. B. the note 3. to the arch A 3. B. and ſo of the reſt: but now all the matter is how to come by the centres without the diametre C D. that ſhall you do very eaſily if you do but giue a note or nicke backwards on the diametrall line beyond C. from euery of the former centres after you haue drawne your arch: as for example, when on the centre 1. you haue drawne the arch A 1 B. then giue a nicke backwards beyond C. your compaſſe vnſtirred, there ſet 5. likewiſe after that on the centre 2. you haue made the arch A 2 B, giue a nicke backwards with your compaſſe at 0. and from the centre 3. your arch A 3 B being made, giue a nicke, backwards at 6. and ſo of the reſt. And now when euery ſeconde pricke of the ſemidiametre haue plaide their parts, then doeth euery ſecond of the nickes that you made backwards ſerue in very like ſort: as for example, the nicke 5. is the centre to the meridian A 5. B. and heere muſt you alſo giue a nicke backwards and there ſet 7. and thus continually making nickes backwards euery ſecond ſerueth your turne, and one centre ſtill finding out another.

Further it is a ſinguler thing to be noted and moſt neceſſarie for examination of your worke. Thoſe nickes or notes backwards do diuide the diametrall line beyond C, into the verie ſame parts as the other part of the ſame diametrall line beyond D. was before diuided from the point A by the degrees of the quadrant A D if your worke be exactly done: yet you ſhall hardly make them agree becauſe the miſſe of the pricke of a compaſſe driueth the nicke backwards marueilouſly out of his place, in ſuch meridians whoſe centres be farre off: wherefore as I haue often ſaid, you cannot vſe too great care in performing theſe things. Hereby you may contrariwiſe perceiue that if from A you had diuided the dyametrall line beyond C. by the degrees of the quadrant A C. then needed you not to haue made or giuen any nickes backwards but taken for your centres euery ſecond diuiſion.

Chapter 5.

How to finde the centres of the parallels artificially.

YOu muſt here alſo firſt draw forth the diametre A B infinitely beyond A & B, as you ſee in this figure: which done you ſhall diuide his extenſion beyonde A, by helpe of a ruler laide on C. and euerie of the degrees of the quadrant A C. euen as in the laſt Chapter you did, then ſet at the diuiſions or notes theſe letters E F G H I K L &c. beginning from A outwards, and likewiſe at euery of the diuiſions of the ſemidiametre of the *Iewel*, place the ſame letters E F G H I K L M &c. beginning likewiſe from a towards the centre: now againe is the iuſt middle betweene any two notes marked with like letters, the centre of the parallel noted with the ſame letter as in this figure you may ſee in the iuſt middle betweene the notes G and G is the centre of the parallel S G T. and betweene H and H is the centre of the parallel Q H R. which by my 3. Concluſion you may finde, and ſo of all the reſt. In the very ſame ſort may you deſcribe the other halfe of the parallels next B. VVell by this time you ſee there is more wayes to the woode then one, more wayes to finde the centres then by the rule of three prickes, which in truth is the verie worſt. In that Gemma Friſius neuer mentioned any thing of theſe wayes might be becauſe he was no mechanicall workeman and practiſer herein.



Theſe be pleaſant and eaſie wayes to finde the centres by, for ſmall worke: but for great worke painefull ynough: for which the deuiſe of three rules with ſinguler help ſupplieth your deſire. Theſe two Chapters yeelde more notable fruite then can be conceiued at the firſt vewe, as (if any man endeuour to proiect the globe into a plaine any way) he ſhall quickly finde: and yet ſhall my 7. booke much more. Note that theſe whole circles of the parallels being drawne rounde as they be in this figure do repreſent the verie almicantares of Stophlers Aſtrolabe, though not for his latitude.

Chapter 4.

How to make the Reete *with all his lineaments.*

NOw at the laſt the *Mater* of this *Iewel* finiſhed, it followeth that I ſhew the making of the *Reete* after my inuention ſo largely promiſed, which doth ſo throughly furniſh it, that where before this ſelfeſame *Mater* with ſuch tedious tackling as Gemma Friſ. had appointed him, was verie troubleſome & vntoward almoſt to euery action, lame as it were & like a nowne adiectiue could not ſtand of it ſelfe without Stophlers *Reete* & his general horizons on the backſide: now it may be pronounced the only mathematical inſtrument of the world exactly, ſpeedily, & plainly performing innumerable ſinguler concluſions to wonderfull purpoſes without helpe of any other, and all onely by meane of this new *reete*. VVherefore to returne to my purpoſe, you muſt get a verie thinne plate the thinner the better, if it hold the working

working whereon make the circle A B C D very iuſt in quantitie with the innermoſt circle of the *Maters Limbe* and marked with the ſame letters in like ſort, and within it make another circle to conteine a very narrow ſpace, for the 360. degrees compaſsing in the *Reete* which I will eall the *Reetes Limbe*, being ſo diuided that euery 5. degree be ſome way noted from the reſt, and muſt in ſmall worke needs be ſo narrow that it wil beare no figures, for it is made more for neceſsitie to ſtrengthen the *Reete* then to any vſe except it be for one quarter to write in the numbers for the almicantares.

VVel, to proceede farther with our *Reete*, diuide the two diametres A B, and C D: ech into ~~108~~ 180. parts, if it may be poſsible, euen as you diuided the ſame diametres A B and C D in the *mater*, being both of very iuſt lengthone to another. Then in the diametre A B from the point A. recon the ſunnes greateſt declination vz. $23\frac{1}{2}$ degrees, among the diuiſions, and there ſet E. and likewiſe from the point B. there ſet F. Likewiſe from the centre towards A, number $23\frac{1}{2}$ degrees there ſet G. and thence towards B as much, there ſet H. as in the great figure you ſee: which done, you ſhall by helpe of the 4. Chapter or 15 Concluſion drawe the arches C F D, and C E D. and within either of thoſe 2. other arches of ſufficient width to make a *Limbe* for our zodiacke, therein to write the numbers and carecters, or names of the ſignes, yet as ſcant as may be, eſpecially the *Limbe* of C E D, which cannot be too narrow: Then ſhall you diuide or graduate the one halfe of our zodiacke vz. C F D into 180 parts or degrees by keeping the rule on the point E. & thence laying him from deg. to degree of the ſemicircle of the *Limbe* C B D. euen as you diuided the diametre C D, of the *mater* from the point A in the 1. Chapter. Likewiſe diuide the other halfe of our zodiacke vz. C E D into 180. parts by laying the rule from the point H on euery of the degrees of the ſemicircle C A D. Reade more hereof in my 4. Booke 4. Chapt. Let euery 30. diuiſion or degrees croſſe the whole *Limbe* of the zodiacke, and euery 10. degree or 5. if you can come halfe way, the ſecond ſpace, which done, then beginning at C number towards E, and ſo round about both the *Limbes* by thirties in manner of the ſignes. At C is the beginning of Aries as in the great figure of the *reete* you ſee written: at D of ♎, at F. of Capricorne the reſt in order: therefore in the bigger halfe zodiacke C F D. you may write their names at large, and in the leſſer C E D, onely the carecters, if your inſtrument be ſmall, and ſo is the zodiacke of your *reete* made to ſinguler purpoſe. But looke in any wiſe that with great diligence and care you get the 4. points E G H F, moſt exactly and heedfully draw and diuide the arches C F D, and C E D, & that their common diametre or chorde C D be full as long and no whit longer then the diametre C D. or A B of the *mater*: or elſe all the reſt of your labour will be loſt. The premiſes performed, you ſhall nowe endeuour to make the azimuthes and almicantares: which to be ſhort is no more but to diſcribe halfe the meridians and parallels of the *mater* cut off in the diametre C D by the 1. Chap. yet on this condition that the ſpaces in ſmal worke may be 2, and 4. that is to ſay, let the firſt ſpace of the almicantares from C D be foure degrees wide, the ſecond 2. deg. wide, the thirde 4. againe the fourth 2. the 5. 4. and ſo to the toppe or zenith. But the azimuthes let them bee by two a piece, like as the meridians are. The cauſe hereof is for that the bigger ſpace muſt be cut foorth and made open as in the 11. Chapter ſhall be ſhewed: In great worke theſe ſpaces would be 1. and 2. or 1 and $\frac{1}{2}$ for euer the more circles the better.

Chapter 7.

How the zodiacke of this reete may be diuided diuerſe other wayes.

I Had thought heere to haue ſpent a long diſcourſe in ſhewing ſundrie wayes to diuide the *reete* by: which giueth the more credite to the proofe of any experiment when the ſame is to be done diuerſe wiſe, and ſomwhat it would haue made any man the redier in proiection of the ſphere for diuerſe purpoſes. But becauſe time is very ſcant with me and that I deſire an end I will ſleightly paſſe them, the rather for that amongſt them all the reddieſt and eaſieſt way is alreadie performed in the laſt Chapter. One way had beene with helpe of a table of right aſcentions, thereby laying the rule in the *Limbe* to the degrees of right aſcention anſwering euery 5. deg. of the zodiacke, ſo you may diuide him into 72. fiues, and euery of thoſe parted into fiue equall parts maketh 360. which by the 3. Booke and 11. Chapter you may well gather. Another way may the zodiacke be diuided, if you place him on the *mater*, ſo that the line C D of the *reete* lye euen in the line A B of the *mater*, So doe the parallels diuide him into 360. degrees: or if you liſt to go to the coſt you might make blind parallels croſsing C D. of purpoſe to diuide him by: this may you conceiue by the 4. Booke 4. Chapt. Another way alſo is by circles of longitude iſſuing from the poles of the zodiacke G H. like to thoſe which Stophler maketh his azimuthes, or thoſe which are drawne in the figure of my Booke. See what helpe here is where no neede is. But ſince it is manifeſted in my 4. Booke 4. Chapt. that the way of the laſt Chapter is moſt exact, ⁊let vs keepe to that becauſe it is eaſieſt.

Chapter 8.

How to place the fixed ſtarres in the Reete.

IT is moſt neceſſary, commodious and pleaſant, to haue as many of the chiefeſt fixed ſtarres in your *reete*, as may conueniently be put in, without ouer much hurt to the other worke, and hinderance of ſeing the lineaments of the *mater* vnderneath. To performe this requireth 4. ſpeciall matters to be foreknowne, either by exact tables, or diligent obſeruations as ſhall be taught hereafter: that is to ſay, the mediation or culmination of the ſtarres, their declination from the Aequinoctiall: whither, North or South declining, and of what light or magnitude the ſtars are. The culmination of a ſtar differeth little from his right aſcention, the one is but the degree of the zodiack, the other the deg. of the equinoctial which commeth to the meridian or any right horizon with the ſtar. Thoſe 4. firſt knowne either by obſeruation as I will ſhewe in the 3. Booke and 39. Chapter: or by the table following which I haue taken out of Stadius a diligent writer, worke thus: Lay the rule from the centre of the *reete* to the degree of Culmination of the ſtar found in the table reconed on the zodiack, and draw there an obſcure line, then ſeeke in the table his declination, & number the ſame in the diuiſions of one of the lines A B, or C D. from the *Limbe* inwards, and then ſet one foote of your compaſſe in the centre, & extend the other to the ſame diuiſion, then turning the moueable foote about therewith croſſe the obſcure line, at this croſsing is the place of the ſtar deſired, or elſe becauſe the plate perhaps may haue too large a hole for the true centre you may take on one of the lines A B, or C D. the ſaide declination and ſetting one foote of the compaſſe where the obſcure line cutteth the *reetes limbe* or circle A B C D, with the other croſſe the obſcure line inwards towards the centre, it ſhall light in the former croſsing. VVherefore there ſhall you forme or faſhion the ſhape of a ſtarre with a point or apex ſomwhat farther out then the reſt, touching onely the preciſe pricke of this croſsing. And if this ſtarre be a North declining

clining ſtarre, then let his apex point outwards from the centre directly towards the *Limbe*, if South declining then inwards towards the centre. For example take the great ſtarre one of the firſt light called Hircus, the Gote, whoſe culmination by the table following I finde to be in the 13. deg. 0. minute of ♊, or his right aſcention 71. deg. 33. mynutes of the equinoctial, both which one line in my *Reete* laide from the centre, doth ſhew at once, if the point D of the *Reete* be laide to the point A of the *Mater*. But here his culmination ſhall ſerue, though from D, I might count his aſcention: therefore laying a rule on the centre and the 13. deg. 0. minutes of ♊ in my zodiacke I draw an obſcure line: then hauing likewiſe found in the ſaid table the declination of Hircus 45. deg. 5. myn. I ſet my compaſſe one foote in the centre, and open the other vnto 45. degrees 5. minutes counted in the line A B, or C D from the *Limbe*, and therewith turning about the compaſſe doe croſſe the obſcure line with a ſmall arch, then do I make by this croſsing the ſhape of a ſtarre with his apex touching the ſame point, and directly pointing outwards, becauſe in the table following I finde his declination North, thereby writing this name Hircus, as in the figure of the *reete* you may ſee. And yet can I helpe you to a neere way by helpe of your *Label* made as in the 12. Chapt. and faſtned in the centre of the *reete*. Lay the *Label* on the ſtarres degree of Culmination, and by the degrees of the *Label* number, his declination inwards from the *Limbe*, and there ſhall be the ſtarres place in the *reete*. Example, I will take another great ſtarre of the firſt light called Foma hand, or *Fuſio aquarii*, I finde by the table following his Culmination the 6. deg. 46. minutes of ♓: vpon which degree of my zodiacke, I lay the *Label* faſtned in the centre as I ſaide, then on the *Label* from the *Limbe* inwards, I number his declination, which by the table I finde 33. deg. 33. minutes, and at the end thereof I make a pricke, which is the place or point of the center of the ſtarre called *Foma hand* deſired, whereto I ſet the ſhape of a ſtarre prouiding that the apex point inwards towards the centre, becauſe I find in the table that his declination is ſouth from the equinoctial, as in the ſaid figure of the *reete*, you may alſo ſee. But heere I would haue you to note how wonderfully this *reete* excelleth Stophlers *reete*, which Gemma Friſius allowed of: for that here you may put in all the ſtars from pole to pole where in Stophlers *reete* you cannot poſsiblie doe it: neither can you put in any one ſtarre there that declineth Southwards aboue 23½ degrees from the equinoctiall, except you will make the inſtrument vnprofitablie huge, for that purpoſe onely. As for example, the laſt ſtarre called Foma hand declineth 33. deg. 33. minutes ſouthward, which cannot be put in Stophlers *reete*, except the inſtrument be made larger by one quarter of the diametre of purpoſe, which will ſerue almoſt to no other vſe, and yet then can you not put in all by a number: but now againe to my purpoſe, when you haue in this manner as is before taught, put in as many ſtarres as you may, which to the number of 30. or. 40. in a ſmall inſtrument may well be, then muſt you linke them togither with ſmall branches handſomly, wherein their names muſt be written, but all in as ſmall roome as may be. And as for thoſe ſtarres which light among the almicantares, if you cannot there write their names, then muſt you ſupplie that want by writing them on the *Label*. Alſo for their bigneſſe of light or magnitude, you muſt either file them of three or foure faſhions which you ſhal hardly do in ſmal worke, or with the grauer, make them ſeueral ſhapes, or elſe you muſt deuiſe to ſet ſo many pricks by euery one as may ſignifie the bigneſſe of their light, either of the 1. 2. 3. or 4. magnitude, which you neede not exceede though they are reckoned to the ſixt. Note that in my great figure I haue ſet to euery ſtar a number, according to his being in the table following, whereby you may there eaſily finde his name.

Chapter 9.

How to finiſh and cut out the Reete *of this Iewel.*

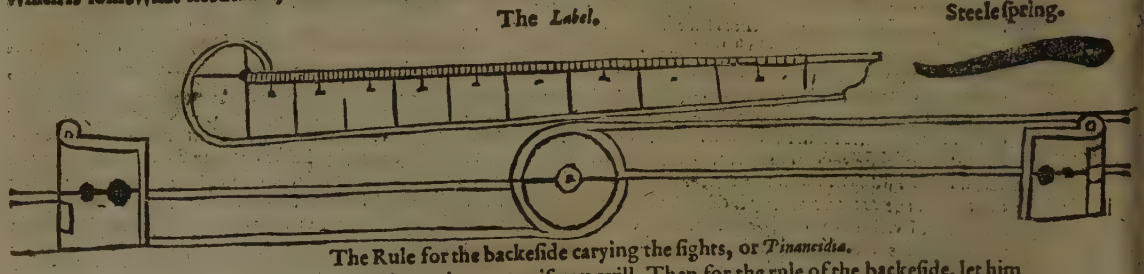
HAuing drawne all the lineaments exactly, and placed the points of ſo many ſtarres as you thinke good, as before is ſhewed: then muſt you graue or write in all the figures names, and carecters, of the circles, ſtarres, and ſignes: alſo the branches that ſhall ſupport your ſtarres with their ſeuerall ſhapes and that as exactly, as though they ſhould not bee filed or cut out: but in any caſe you muſt not ſtampe any figure, letter, or thing in a thinne plate: one blow may bring the whole out of frame. In any wiſe deſire not to make your *reete* of any thickneſſe, for in vſe it will be very vnpleaſant in many reſpects, the thicknes of a grote will ſerue very wel. VVhen you haue performed al this, then muſt you with fine files (or being in paſtbord, with a fine penknife) cut out al the ſuperfluous roomes of the *reete*, and euery greater ſpace of the almicantares, leauing nothing but the very zodiacke, the ſtarres and their braunches whereon their names are written, and euery leſſer ſpace of the almicantares, as in my great figure you may well perceiue. You ſhall finde it a very harde piece of worke to file out theſe things in mettall: eſpecially the almicantares, and to leaue the ſtarres there placed: and if you be not verie carefull, you may ſoone ſpill all: if you can get no file thinne ynough, you may grinde a file on one or two ſides till he come to your purpoſe. But to be the more ſure to keepe the almicantares from diſplacing, which is all my care, you ſhall leaue heere and there ſuperfluous ſtrings very ſlender in filing euery almicantare, which you ſhall not file away till you haue all done: and if you liſt at euery 10. 15. or 20. azimuthes, ſmall ſtrings quite through, as in the 4. Booke 1. Chapt. is ſaid, they will not onely keepe more ſure the almicantares at their true width, but alſo be a great eaſe in vſe of the *Iewel* for ſpeedie reckning of the azimuthes. And if there chance any ſtarres in your way, be chary to faſhion them as well as the roome will giue leaue: and alwayes be ſure to keepe your drilles, grauers, and all your tooles verie keene and ſharpe by often whetting, elſe ſhall you both worke tediouſly and hardlie keepe your worke from forcing in thicke plates, ſuch as the *Mater* muſt be made of: you may be ſomwhat bolder to ſtampe ſmall figures, letters and ſmall holes, and to peirch, but chiſill you muſt not, nor ſtrike with great pounches: I had forgotten it in the 8. Chapter, you muſt leaue a rule bredth vnder the line C D of the *reete* wherein to graue the numbers from 10. to 360. beginning at the centre and thence to C, there ſet 90. from C. to the centre backe againe, ſet 180. from the centre to D. 270. from D backe to the centre end in 360.

Chapter 10.

How to make the Label *for the* Mater *and the rule to the backeſide with ſightes.*

THere is neither of theſe two harde to make, for they are common to euery inſtrument, and may be better perceiued by theſe figures then by many words. The *Label* is but a rule in length equall to the ſemidiame-

tre of the *Iewels Limbe*, containing halfe the diuiſions of the line C D. whoſe loope about the centre hole muſt be ſlender as may be, and therefore I would haue you get a little ſpring of ſteele in length halfe the *Label*, to riuet to the centre next aboue it, which ſhall not onely keepe downe the *Label*, to ride about continually with the *Reete* which is ſomewhat needefull, but alſo it ſhall much ſtrengthen the loope at the riuet: let the *Label* be numbred



The Rule for the backeſide carying the ſights, or *Pinacidia*.

from the centre to 90. at the *Limbe* and backe againe to 90. if you will. Then for the rule of the backeſide, let him be equall to the whole diametre of the backe of the *Iewel*, bearing two folding ſightes, ech hauing a great hole for ſtarres and a little hole for the ſunne beames in manner and faſhion of common Aſtrolabes: all which by theſe figures you may ſufficiently ſee. If you would be preciſe this rule ſhoulde be ſomwhat thinne: leaſt the verie weight of him ſhoulde cauſe your *Iewel* to hang awrie in taking altitudes, as we commonly ſee in the beame of a ballance, if the one end once get a little higher then the other, it then waigheth the other quite downe: which alſo *Cardanus* confirmeth in his Booke *De ſubtilitate rerum*, but then if you make your rule thinne you had neede ſet on a narrow *Limbe* on the backſide for the rule to ride vnder, leaſt it ſhould elſe take harme, which will alſo helpe well to giue the *Iewel* weight.

Chapter 11.

How to furniſh the backe of the Iewel *with the Theoricke of the ſunne and other neceſſaries.*

THis inſtrument, nay rather this *Iewel* doth alredie ſo fully ſupplie all the multitude of tables, which Stophler appointed like a box of trenchers iumbled togither within the *maters Limbe*, & all other knicke knacks, which G. Friſius would needes haue to be annexed and pertinent to his *Catholicon*, and generally all other inuentions for Aſtrolabes whatſoeuer, with much more then euer any of them coulde performe, yea or almoſt the globe or ſphere it ſelfe: that in manner it leaueth nothing to place on the backſide but onely the Theoricke of the ſunnes motion, with the kalender, and that for faſhions ſake more then any neceſsitie, if a man had alwayes an Almanach or *Ephemeris* about him. But becauſe thoſe are not alwayes at hande: and that ſuch hath beene euer the vſe in all Aſtrolabes: it is not a miſſe, not to digreſſe from the olde faſhion. And therefore thus ſhall you do. Make two *Limbes* ioyning togither the one for the zodiacke or circle of ſignes: the other for the kalender or circle of monethes. Let the zodiackes *limbe* containe 3. ſpaces, though in my figure I haue made a ſhift with 2. the 2. outermoſt ſpaces of like bigneſſe, one to receiue the names or carecters of the ſignes, the other their numbers from 30. to 30. which in my figure are both in one, the third ſpace to be narrow for the deg being in the whole 360. This *limbe* being thus diſtinguiſhed and diuided by helpe of the 20. Concluſion croſſe, the whole with two diametres ſquare into foure quarters, but ſo that the one diuide the middle of the handle, where you ſhall beginne ♈ at the other end ♎, at the other diametre leftwards ♈ to beginne, and rightwards ♋. All which performed, draw a line from the centre to the 2. degree of ♎, deuide the ſame into 25. parts, and in the neareſt of them to the centre, make a ſmall centre hole placing it on the centre of ſome great circle redie diuided into 365. & $\frac{1}{4}$ equall parts by the ſaide 1. Booke 20. Concuſion, ſo that the 21. deg. of ♍ in your circle of ſignes lie, on the beginning of the ſame $265\frac{1}{4}$ diuiſions in your bigger circle, and ſo by helpe of your diuiding rule placed thereon, diuide the *limbe* of monethes in your *Iewel* into $365\frac{1}{4}$ parts or dayes from this excentricke centre, which *limbe* muſt be firſt drawne and ſeuered into 4. ſpaces, though in my figure I haue made but three. The firſt and outermoſt ſhall ſerue for the names of the monethes, the ſecond to ſet in the figures or numbers of the dayes to euerie moneth 10. 20. 30. or 31. as the moneth requireth, the third for the $365\frac{1}{4}$ equall diuiſions of the dayes: the fourth very large for to ſet in the feaſts or ſaints names.

Ianuarie muſt beginne at the ſaid 21. deg. of ♍, the reſt in order, all which I haue contriued in the circuler ſpaces without the circle A B C D of the great figure of the *reete* being loth to make a ſtampe of purpoſe, and therefore marke it well. If your *Iewel* were large ynough, then were it good to write the weeke letters A B C D E F G, in or to euery of the $365\frac{1}{4}$ diuiſions as they are in the Almanacke, and as in the ſame figure I haue begunne at Ianuary. And when you haue thus performed the theoricke with the kalender, yet will there be a great roome left: wherein they are wont to make the Geometricall quadrat, and the planetarie houres: but to how ſmall vſe both theſe are in little inſtruments, let them iudge that haue had of them. And as for that kinde of planetarie houres, the making of them being ſomwhat comberſome, the vſe of them trobleſome, and their beſt vncertaine by reaſon of the ſtrickt neſſe of the houre circles about 12. and the tropicke of ♍, I am therefore out of loue with them, and ſpecially for ſmall inſtruments, and rather becauſe ſo troubleſome a thing ſerueth but to one purpoſe, and to one latitude, and the ſame purpoſe is verie wel to be performed on the *Iewel*, as in the third booke is ſhewed. VVherefore the premiſes conſidered, if you will be ruled by my direction, I would haue you furniſh vp the backe of your *Iewel* one of theſe three wayes. The one is if you will take a little paines to make 6. circles one within another, conteining ſixe equall ſpaces: And in the three outermoſt of them to appoint two ſeuerall tables, one for to knowe the Dominicall letter for euerie yeare, the other for to finde the Prime and Epact. In the three innermoſt

ſpaces

Yeare of our Lord.	1582	83	84	85	86	87	88	89	1590	91	92	93	94	95	96	97	98	99	1600	1601	2	3	4	5	6	7	8	9
Dominicall letter for leape yeare.			E				G				B				D				F				A				C	
Dominicall letter.	g	f	d	c	b	a	f	e	d	c	a	g	f	e	c	b	a	g	e	d	c	b	g	f	e	d	b	a
Yeare of our Lord.	1577	78	79	1580	81	82	83	84	85	86	87	88	89	1590	91	92	93	94	95									
Prime.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19									
Epact.		11	22	3	14	25	6	17	28	9	20	7	23	4	15	26	7	18	29									
Prime.	16	0	13	2	0	18	7	0	0	0	15	4	0	12	1	0	9	0	17	6	0	14	3	0	11	0	19	8	0	0	0	0	0	0
Dom.let.	d	e	f	g	a	b	c	d	e	f	g	a	b	c	d	e	f	g	a	b	c	d	e	f	g	a	b	c
March	22	23	24	25	26	27	28	29	30	31	April.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25

You shall gather this Table round at your owne discretion.

spaces to appoint a table whereby to know on what day of the moneth Easter day shall fal for euer, in such sort, as in this table is expressed. A second way, is necessarie for him that studieth Astrologie, to place in this voide roome the three rounde tables which Claudius Dariotus in his book intituled: *Introductio ad astrorum iudicia*, doth shew if you can deuise to packe them one within another, as I haue done the other three tables, or at least one or two of the most necessarie. That, booke is now in english: wherefore you may haue those tables printed for little. A third way is the best of all, and most necessarie for the traueiler, and pleasant to all sortes, and in especiall for any Gentleman, to place in this vacant roome the better halfe of the worlde in plaine, that it to say, from the north pole to the south tropicke, which in diuerse authors you shall see, as in Apians Cosmographie, who calleth it there, his Cosmographical glasse: some wil think the roome too little, indeede you had need in smal instruments make the circle of monethes narrow, by the space wherein the saints names are written, leauing them out quite, and then no doubt it may serue well, for I haue seene contriued the Cosmographicall description of the one halfe of the world in a round tablet, vnder 3. ynches diametre, and most curiously grauen in many notable cities and places in euery countrie, with their names ascribed very sensible.

Chapter 12.

How to set together all this worke of the Iewel.

HAuing now performed all the seuerall parts of this *Iewel*, except you will place starres in the *mater*, by the 3. Booke 17. Chapt. which I thinke needelesse, the handle onely excepted, which is an ordinary thing to make, consisting of two or three pliant ioynts. or lymmoes, so ordered and appointed, that one of the diametres on the backside may hange very perpendiculer from the zenith alwayes in taking altitudes, as by certaine figures before you may partly see: I thinke there is now no man of any sense, but can set them togither: yet I thought good to note thus much by the way. First for the centre holes of the *Mater*, *reete*, rule and *Label*, let them be all of one euen bigneese, and as small as is possible to beare a riuet. For it is a foule fault to haue a great many degrees at the centre, taken vp with the riuette and the loopes. Secondly it would be so contriued if the workman be cunning, that part of the *reetes Limbe* might ride vnder the *limbe* of the *mater*, which for that cause would be set vpon the *mater*, in manner of the old Astrolabes: or if one did but hammer out 4. or 5. tets out of the *reetes Limb*, in euery quart. one, it shal suffice ynough to ride vnderneth which woulde be a great preseruatiue to your *reete*, least euery little strain of any thing that should get vnder it do lift him vp, should straight breake him off at the loope, or centre hole, being so thin as indeede he must be. I haue had experience to my cost: and thus my gentle *Iewel* I wish thee well to fare.

Here followeth the inuention, definition, and explanation of the *Iewel*, and of euery circle, part and thing therein conteined.

Chapter 13

VVhat moued the author to his inuention of this Iewel, *and whence he obtained it.*

AFter I had no small time traueiled as far forth as my leisure wold license me, in the most part of the Mathematicks. namely in Geometry, Arithmetick, prospectiue Cosmography, Topographie, mensurations & such like, I think by the space of 8. yeares or more, and then at the last being drawne on by the studie of Cosmograpy. to the desire of Astronomy (which 2. cannot wel be in sunder) I thought it my best course about sixe yeares past, to craue the conference of one Thomas VVhite, Vicar and curate of Berkham being fiue miles from Reading, of whom I heard verie well of for his studie that way. I went to him, I founde him no lesse ioyfull of my comming, then I was carefull of his acquaintance, but his studie that way was altogither Astrologie, Phisicke, &c. where my desire was Astronomie, so that my hope of his helpe was almost on the sodaine frustrate: but there I founde such choise of Bookes for my purpose, that I repented not my comming, where he on the other side hauing heard greater speach then was cause perhaps of me, and my practise, in painting, drawing, grauing, and such like, would needes craue my helpe to make him a Catholicon Astrolabe, and to that ende he deliuered me Sconer, Stophler, Roias, and Gemma Frisius Bookes, of their seuerall Astrolabes: but aboue all other he commended vnto me, as there was cause, Gemma Frisius.

Notwithstanding because I would be acquainted with all their inuentions, I perused them all, and founde that Stoners deuise was very stale,& the making combersome & vncertaine by reason of the diffuse traduction thereof, Stophler his was artificall, and in truth that which hath giuen light to all the rest, yet requiring so many tables as there be diuersities of the poles elevations in the world,or at least so many plates as you require countries: For the astrolabe it selfe serueth but to one latitude which to a traueller into diuerse countries were both chargeable and combersome:& to a student not altogether pleasant considering he must take out & put in stil those tables that are required. Then I come to Roijas and Gemma Frisius,which in effect haue al one scope,though Roijas be farre inferior to the other, because his parallels be streight lines, and his meridians not arches but rather certaine geometricall crooked lines called Ellipses which come *ex sectione piramidis*,and those parallels towards ech pole & the meridians towards the *Limb* grow so neare togither that one drownes,another which is a very great fault, whereas G. Frisius his parallels and meridians haue conuenient spaces, and are all of them true arches of circles, and in effect such and no other then the circles in Stophler be, which he calleth almicantares and generall horizons,and therefore must needs be more proportionable to the circles of the sphere *nam rectilineæ ad curuam nulla est affinitas*. Notwithstanding al this, though Roijas and Gemma Frisius were singuler inuentions being generall to all the worlde, yet both of them were so combersome in my fancie that I could not well brooke them: For besides that, that they required one or two plates within the *mater* to be taken in and out,and also Stophlers moouer called the *reete*, to helpe him with his generall horizons, the cunning not little to make their *regula cursor & Brachiolum* exactly, with the screw pinnes ioyntes and such like,yet when all was done,the working of conclusions by them so tedious with often assaies and so vncertaine for slipping of any ioynt, or iogge, that without many profers and twise performance one could not be assured of any proposition. All these when I had read and well considered I coursed many a sundrie deuise for amendment thereof: at last though it were long first, it pleased God to suffer me to attaine vnto the very perfection of the thing I shot at, euen to perfect one plate and one moouer to serue to all purposes redily without profers,which I haue at the last done: but not without participating some of euery of the astrolabes before recited,so that my worke might iustly not vnlike to the first columpne or piller in architecture added by the Romans, be called *Astrolabium campositum* if it deserued not a more ample name as the sequele shall manifest.

Chapter 14.

Of the definition of the Iewel *and his principall parts.*

TVllie about the beginning of his first booke of offices, saith that euerie thing that any man will entreat of, ought first to be begunne from the definition: this instrument or *Iewel* therefore(if any man will aske what it is) is a certaine round superficies or flat forme representing the solide globe and sphere, and euery circle in them contained or imagined,being so proportionablie, congruently,and artificially by prospectiue lineaments protracted,that it performeth the whole vse of the globe and sphere in euery respect whatsoeuer,and rather more then lesse and in effect by the selfesame methode. This instrument or any such like: some writers haue called *Planisspherium* a plaine sphere, but the most part *Astrolabum* or *Astrolabium* an astrolabe: the first springeth of the traduction or deriuation of the thing it selfe,sounding as it were *Sphera in plano* a sphere or globe in plaine forme. The second commeth of the qualitie or vse called, *Astrolabium quia monstrat lapsus astrorum*, bicause it sheweth the gliding or course of the starres. And in asmuch as the vse of the instrument is more often called in question and practised then the traduction and deriuation, therefore the name astrolabe is more common then plaine sphere. But I finding the vse of this instrument so infinite and vnspeakeable, haue not without cause named it the Mathematicall *Iewel*. To proceede further, whereas all other Astrolabes haue many,this onely hath but seuen principall parts. The first is the ring and ioynt whereby it hangeth called in latin *Suspensorium* the hangle because it hangeth thereby, or *Ansa* the handle becaufe men commonly take and holde it thereby. The second is the round brim that encloseth the worke of the *mater* called in Latin *Limbus*, the *Limbe*, which is as much to say as the brimme, garde, or creft of a thing. The third is the worke within the *Limbe* which I will call by the latin word *mater*(the mother) as well becaufe it containeth the whole worke of the sphere within it, as also for that it is enclosed in with the *Limbe*. The fourth is the mooucr on the *mater* called in latin diuerse wayes *Voluellum* the mooucr becaufe it performeth his office by motion,also *Arania*, the web,becaufe itis cut out somwhat like the spiders cobweb: lastly, *rete* the nette,becaufe it is like a nette,but I will call it according to the latin *rete*, or rather the *reete* more englifh like. The fift is the *Label*, called in latin *Index* or *ostensorium*, the shewer or pointer of some *Almuri*. The sixt is the backe of the Astrolabe, called *Dorsum astrolabi* for the most part,which I shall call the theoricke, becaufe the chiefeft matter there,in common vse,is the theoricke of the Sunne. The seuenth is the rule of the backside, carying the sightes called of some *Alhidada*.

Chapter 15.

Of the diuision or two seuerall distinctions of this Iewel.

THis *Iewel*,becaufe it is a thing gathered and compounded of all the writers of Astrolabes that are commonly extant,as I haue before said may be likened vnto the worke of Bees in that, that out of the sweete substance gathered of the fresh flowers,is made both the Hony and Honie combe, the one to support the other, and very like in deede to a *Iewel* that is made of precious stones and golde one to hold in another. Euen so in this my *Iewel* there are two sundrie instruments so vnited and compact that the one defaceth not the other, but of necessitie the one helpeth the other and in trueth without the one the other cannot be general. And euen as the Honie is moist and the combe stiffe, the golde will be forged, but the precious stones will not melt: so the one parte of this instrument performeth all his conclusions fixed, the other by continuall motion about the centre. I would not haue you take my meaning that the *mater* shoulde be one instrument and the *reete* another seuerallie, but they are ioyntlie two instruments for part of the *reete*, and the *Limbe* and all the circuler lines in the *mater* serue to the

one

one, and but part of the lineaments in the *Mater* and *Limbe* and part in the *reete* serue to the other, as heereafter followeth.

Chapter 16.

Of the dispositions of the circles both in the Mater, Reete, *and* Limbe, *for the first and chiefest distinction of this instrument.*

COncerning the two distinctions of this *Iewel* mentioned in the last Chapt. the first and chiefest is in effect agreeable to Roijas and Gemma Frisius inuention, and seruing to so many the vses of their Astrolabes as are performed without Stophlers *reete*, and to innumerable other, as I will manifest, requiring part of my *reete*, part of the *Limbe* & all the *Mater* to serue his turne. First therefore for this vse the *Limbe*, first two spaces within the first great blacke circle is deuided into 4. times 90. degrees numbred from the equinoctiall line to ech pole. All the lineaments of the *mater* are required to this distinction, which euery man may easily of himselfe discipher, that hath any knowledge at all, or hath redde my first booke. For the circles meeting togither all at two points which are called poles, are meridians or houre circles, the other sort crosing them square as it were growing lesse and lesse from the diametre or equinoctiall line C D, till they come to ech pole, are called parallels. The circles or lineaments in the *reete* seruing this, are called Almicantares and azimuthes: the almicantares called in latin *Circuli altitudinum* circles of height, are those which are drawne in ech respect like the parallels in the *mater*, and are cut out like the spiders webbe. The Azimuthes called in latin, *Circuli verticales* verticall circles, are those which are drawne cutting all the almicantares meeting altogither at one point, where the almicantares growe to nothing: which point I call the zenith point of the *reete*, and is marked with A. these Azimuthes are drawne no otherwise then the meridians in the *mater*, but that they are cut off in halfe: The first Almicantare is the streight line crosing the centre of the *reete* vz. C D. and from thence are the rest numbred to 90. ending at A the zenith point: this streight line or first Almicantare C D, is in truth the horizon or *Finiter*, & is to be set fixed to any latitude, but for distinction sake I will henceforth call this horizon line the *Finitor*, or *Finitor* line, because I must call other circles in the next Chapter horizons, yet in plaine english they both are one. The rule bredth in the *reete* wherein in trueth are written the deg. of the horizon, and therefore might altogither with the *Finitor* line be called the horizon or *Finitor*, yet in respect it must serue the steede of a rule verie commonly, I will call it the rule at many times.

Chapter 17.

The circles seruing the first and chiefest distinction knowne by the last Chapt. how to place them to the latitude of your countrie, where it shall rest fixed to all conclusions, a few excepted euen in manner of the globe or spheere with a further exposition of the lineaments of the Iewel *so placed.*

YOu shall vnderstande that in those parts of the world, where the two poles be leuell with the horizon and neither of them eleuated, they are said to haue horizon *rectus*, a right horizon, which is where the equinoctiall is zenith: wherefore place your *Finitor* line so, that he be euen with the axtree line, and you shall see the zenith to be in the equinoctiall line: so is your *Iewel* now set to the right horizon, and there being, performeth all or most of the conclusions of any right horizon whatsoeuer. But now to my purpose where one of the poles and axtree lines are eleuated any whit, there is it called horizon *Obliquus*, and looke how many degrees the pole is eleuated, so many degrees must you recken from the pole of your *Iewel* leftwards one of the *Limbe*, and thereto set the *Finitor* line or first Almicantare, and so is your *Iewel* set to the latitude, euen as the globe it selfe is set, and by the same reason. For example, I would set my *Iewel* to the latitude heere at Reading, either I get the height of the pole instrumentally as hereafter shalbe shewed, or out of some Cosmographers tables I finde it to be 52. $\frac{2}{3}$ degrees. The pole on the left hand of my *Iewel* marked with A, is the north pole, from him I reckon downewards 52. $\frac{2}{3}$ degrees on the left hande also, and thereto I place the *Finitor* line, so that the zenith be vpwards towards the handle: and let the *Iewel* remaine so fixed as it were, for there is he placed to our latitude and redie to resolue any question you will aske: there presently may you see the sunne rising, the length of the day, the heightes of the sunne, the houre, with a number of other matters, euen this booke full, *Vno momento*, as hereafter shall be shewed: therefore when I say hense forwards place the *Finitor* to the latitude, remember this, that I meane place the *Finitor* line so many degrees vnder the pole, as the pole is eleuated in the region or place proposed, although I might better bidde you place the zenith point of the *reete* so many degrees aboue the right ende of the equinoctiall, all commeth to one, but this is easier to vnderstand. And now to proceede farther, the *Finitor* being thus placed vnto the latitude, and so remaining you shall vnderstand that your *Iewel* symetrially representeth the verie situation of the globe or sphere to the same latitude with all their circles and furniture. For to beginne with all, the *Finitor* line represents the horizon with the numbers thereof: the innermost circle of the *Limbe* is the meridian, representing also the *Colurus solstitiorum* and alwayes serueth the vse of the meridian or noone line to euery latitude. The points in the same meridian, where all the meridians doe meete vz. A and B. are the poles that on the left hande of the handle vz. A. the pole artike or North B. the antarticke, the diametrall line lying betweene these poles videlicet A B, is the axtree line, and representeth the *Colurus equinoctiorum* and the 6. of the clocke houreline to euery latitude, the line which cutteth the centre comming from the handle vz. C D, which crosseth square the axtree line A B, is the equinoctiall, the rule applyed thereto sheweth his numbers and diuisions: the circuler lines meeting at the poles A B are meridians and in vse serue for houre lines, and circles of right ascention, of which euery 15. is separated with prickes to serue our common houres, the axtree line being 6. The circles of like width in the *mater* beginning from the equinoctiall C D waxing lesse vnto ech pole, are called parallels or *Circuli parallelli*; and in vse doe limit the declination of the sunne, moone, planets, starres, or any place or point of the heauens from the equinoctiall the 23. $\frac{1}{2}$ parallel on ech

side

ſide the equinoctiall ſeuered, which prickes are the tropickes, and the 23. $\frac{1}{2}$ parallel reconed from ech pole, are the pole circles: further the line drawne from tropicke to tropicke, cutting the centre and onely there touching the *Limbe*, is the eclipticke line: at the centre is the beginning of ♈ & ♎, the reſt in order accordingly, the rule applied to this eclipticke ſheweth the degrees, and euery 30. degrees make a ſigne. The axtree line being the 6. of the clocke line at morning and euening, as I ſaid, euery 15. meridian repreſents the other houre circles, the *Limbe* it ſelfe being 12. of clocke at noone and night, the reſt in like order, as they be figured. Then to come to the *reete* ſtanding ſtill in the ſame ſcituation, the almicantares are the circles of altitude, reconed from the *Finitor* as in the laſt Chapter: the azimuthes are the verticall circles, the Eaſt azimuth paſsing from the centre directly to the zenith, I call the zenith line, which is alſo the aſt line, and firſt azimuth, and from him they are numbred towards the ſouth rounde to 360. Some haue called the Eaſt azimuth ſimplie the verticall circle. Now laſtly to make ſhort of all, the *Finitor* being ſtill at the ſaide latitude, this *Iewel* repreſenteth in all points the verie lineaments, that you ſhould ſee on a cleare plaine glaſſe placed perpendiculer, quite through the middeſt of the Globe in the plaine or flatte of the meridian circle, and the eye placed in the point where the Eaſt azimuth, and the equinoctiall do meete the horizon vz. in the centre. Or thus more plainely, if you had a Globe of chriſtall with all the meridians, parallels, azimuthes, almicantares, and the horizon drawne thereon, in the middeſt of which chriſtall globe, a plaine chriſtall glaſſe were placed, diuiding the globe in the plaine of the meridian into two hemiſpheres, and this done you did place your eye in the verie Eaſt, or VVeſt point of the horizon, and that you could drawe all the lineaments of the hemiſphere againſt you on the plaine glaſſe as your eye there ſeeth them, they ſhoulde be the verie ſame as the lineaments of this *Iewel* are.

Chapter 18.

Of the diſpoſitions of the circles both in the Mater, Reete, *and* Limbe, *for the ſecond diſtinction of the* Iewel.

THe ſecond diſtinction of this *Iewel* mentioned in the 15. Chapter, is in effect agreeable to the inuentions of Sconer, and Stophler, and ſupplieth the ſteede of Stophlers *reete*, and generall horizons, which Gemma Friſius would needs haue anexed to his Aſtrolabe, as an inſtrument by it ſelfe, but a great deale more effectuall then it in many points, as hereafter wil appeare, though perhaps it ſeeme ſomewhat intricat at the firſt blemiſh, yet once in vſe, as eaſie as the other. For this ſecond diſtinction ſerueth the innermoſt ſpace of the *Limbe* and hath two diuiſions, the one beginning from the point A, and ſo leftwards rounde vnto 360. the other diuiſion is into twiſe 12. ſeruing to the ordinarie houres: the point A which in the firſt diſtinction was the North pole, is now 6. in the morning, and ſt B there the South pole is nowe fixe at euening, the points C and D in the firſt diſtinction bounding the equinoctiall, are now 12. at noone and night, the reſt accordingly. Then to come to the lineaments of the *Mater* ſeruing this part, there is a great alteration, for the innermoſt circle of the *Limbe* which in the other part was the meridian, is heere the equinoctiall, the axtree line A B, is here the Eaſt line and repreſenteth the *Colurus equinoctiorum*, and the equinoctiall line C D is heere the meridian or noone line, and repreſenteth the *Colurus Solſtitiorum*, the centre repreſenteth the two poles of the world, and the meridians are here become generall horizons: the ſubſtance of the *Reete* ſeruing this part is but the zodiack and the fixed ſtars. The zodiack is diuided into ſignes and degrees, and the ſtarres haue their names aſcribed: and where, in the former part the *Reete* was to be fixed to any latitude: heere the *Reete* is euer mouing about the poles, being the centre in all his actions. And in few words if the plaine chriſtall glaſſe mentioned in the laſt Chapter did diuide the globe furniſhed with all neceſſarie lineaments in the equinoctials flatte, and your eye were placed in one of the poles, you ſhould ſee on the plaine glaſſe the verie lineaments of this part of the *Iewel*, rebounding from the vnder hemiſphere, only this except, that there would be two eclipticks drawne on the chriſtall globe one croſsing another ſquare, if you woulde ſee both the halues thereof, as on my *Iewel* they are made.

Chapter 19.

A farther declaration concerning the ſecond part of this Iewel *for the zodiacke, generall horizons, and fixed ſtarres.*

I Declared before in the 17. Chapt. that the oblique horizons alter with euery degree of the poles eleuation more or leſſe, but now am to inſtruct you in two things for your better vnderſtāding, the one is, that there is accounted but 90. ſeuerall differences of horizons through the whole worlde (in reſpect of the latitude, becauſe when the equinoctiall is leuell with the horizon, then the pole being zenith can be but 90. degrees eleuated: and being there at the heigheſt muſt needs wax leſſe againe: you will ſay there be 90. to the North pole, and 90. to the ſouth, ſo there are yet in this part of the *Iewel* one 90. ſupplieth both. The ſecond thing I am to minde you of is, that as all great circles of the ſphere croſſe ech other iuſt in halfe, as in my 5. Booke ſhalbe ſhewed: ſo euerie horizon howſoeuer he lie in the world, yet deuideth he the equinoctial becauſe they are alwayes both great circles of the ſphere, into two equall parts, and the one halfe lieth on the North part, the other on the South part of the equinoctiall, and ſo likewiſe of the zodiacke being alſo a great circle. Further you ſee that in this *Iewel* there be but 180. meridians, or rather halfe meridians, euerie one of them being in proſpectiue a ſemicircle, euen the axtreeline A B it ſelfe. ſo that in trueth they are 180. ſemicircles which are 90. whole circles, and muſt be numbred from the axtree or rather here to be called the Eaſt line A B, on ech ſide to the *Limbe* ending there at 90. Then ſatiſfie your ſelfe thus that you haue by this meanes 90. whole circles called horizons euerich of them taken with his match equally diſtant on ech ſide from the axtree line A B, which line A B is a whole circle it ſelfe. Then muſt you take this of almes from proſpectiue, and looke for no demonſtration thereof at this time of me, except my leiſure were more then it is: for in trueth it is ſomwhat holpen by this maxim: *Oppoſitorum ſemper eadem eſt ratio*, otherwiſe it would proue but *rudiori minerua*. I ſay that thoſe halfe horizons which lie on the North ſide of the axtree line A B. that is to ſay, next the midnight point of the noone line, are the North parts of the horizons, that is to ſay, by reaſon of their interſection,

lying

lying on the North side of thequinoctiall : which here as I saide is the innermost circle of the *limbe*: and the halfe horizons lying on the South part of A B next the handle of the *Iewel*,are the South parts of the same horizons: the centre of the *Iewel* being centre to them all : and you must imagine, that (they all crossing thequinoctiall) the one sort is on this side, the other beyond,and yet are foreshortned by meanes of their erection and depression from the eye prospectiuewise : and so likewise for the zodiacke in the *reete*, the North halfe must be imagined to lie northwards, and the other halfe crosing thequinoctiall to lie southwards, and to be foreshortned or thrust togither as painters terme it by placing of the eye. Now by this time I hope you wel vnderstand me how these 180. halfe meridians are become 90. whole horizons: I think you be not ignorant that these 6. signes ♈ ♉ ♊ ♋ ♌ ♍ are north signes that is, alwayes lying on the North side of thequinoctiall, and the other sixe ♎ ♍ ♐ ♑ ♒ ♓ south signes, and lying on the southside. then will I conclude the scope of this Chapt. which is, that you must know and alwayes remember (therefore note it well) that the North signes in the zodiacke must alwayes rise and set on the North part of the horizons,& the south signes on the south part,& so likewise the North stars to rise & set on the north part of the horizons,& the south stars on the south part: note that in my *Iewel* for distinction sake,the north starres do point outwards from the centre towards the *Limbe*, and the south starres inwards towards the centre. Further though I call them henceforwards north horizons, and south horizons for breuitie sake, yet I meane the north part and south part of the same horizon, or horizons. For the starres magnitudes looke in the 7. Chapter. Lastly the verie point or tippe of any starre in the *reete*, I will call his apex.

Chapter 20.

How to choose out which of the 90. horizons serueth to euery countrie.

BY the 20. Chapter you may gather thus much that the pole article or point A. in this second operation is the East point, the point B V Vest: at the handle South, or noone: and at the lower part, north or midnight: & are so to be written in those parts of the *Iewel* vz. East, V Vest, North, and South, and nowe to choose the horison to any place, get the latitude thereof either by tables, or else by obseruation, as shall be shewed: and then remembring that the centre is now become the pole or poles, reckon so many horisons from the centre on ech side as the degrees of latitude come to, and the horison there ending is your desire. For example, I would know which of the 90. horizons doth serue heere for our towne of Reading : the poles eleuation or latitude (all is one) is $51\frac{2}{3}$ as I said in the 17. Chapt. therefore for my horizon I reckon from the centre being here the pole, and that northwards on the noone line $51\frac{2}{3}$ degrees, and as much on the noone line southwards. the horizon there, is the south part of the same: so I conclude that those two halfe horizons are the whole horizon, seruing Reading, & because I most remaine in that place, I shall haue little neede of any of the other, and therefore I distinguish him out with prickes or some other deuise, whereby I may readilie see him at all times from the rest, and so am I well for my horizon as long as I remaine at Reading, but if I trauaile southwards or northwards to Northampton, Barwicke &c. then must I choose another horizon according to the latitude of the place, as before, to serue my turne as long as I am there.

Chapter 21.

How the Zodiacke and fixed starres rise and set on the horizon now found.

THe *Iewel* in this second distinction is diuided into foure quarters by the East line, and noone line as you see. The first quarter, betweene north and east, is the north east quarter, the second towards south, the southeast quarter, the third from south to west, is the south west, and the fourth from west to north, is the north west. Now thequinoctiall alwayes riseth and setteth full east and west, that is in the points A and B, and therefore as manie starres, planets, or other points of the heauens as happe in thequinoctiall, as namely of the zodiacke the degree beginning ♈ and ♎, & therefore the sunne there being doth alwayes rise and set full east and west, euen in the points A B, but of all other starres, points, signes, and their parts or degrees that lie some north, some south from thequinoctiall, some part must needs lie north, and some south from it, and are therefore called north and south starres, points and degrees, according as they lie: then in reason you may well conceiue that if thequinoctiall do alwayes rise east, those starres or signes that lie north from it, must needes rise on the north east quarter of the horizon and set on the north west quarter. And likewise the south signes and starres must needes rise on the southeast quarter, and set on the southweast of the horizon : and that which more is, if in any latitude any starres lie more north or south then thequinoctials height is, in the same countrie such north starres be continually aboue the horizon and neuer sette, and such south starres be continually vnder the horizon, and neuer seene in that country. An example would not be amisse here to helpe a beginner in the first entrance : admit I would see where about the great starre called *Arcturus* or Bootes riseth in our horizon, now because I know him to be a north starre by the 19. Chapt. I turne about my *reete* till his verie apex come to our horizon, founde by the last Chapter, in the north east quarter of the *Iewel*, for there doth that starre alwayes rise : and then laying the rule to the degree of the sunne in the zodiacke, it shewth in the *limbe*, the houre of his rising: but that shalbe shewed hereafter. Nowe to know where *Arcturus* sets, turne the *reete* till his apex doe touch the said horizon in the north west quarter, and there is your desire. Then admit I would see where the great starre called *Fomahand* being a south starre, doth rise and set, I turne about the *reete* till his apex do touch the horizon in the southeast quarter, there he riseth alwayes, then turne about the *reete* till his apex do touch the horizon in the southwest quarter and there the starre setteth alwayes, the rule then applied to the degree of the sunne sheweth the houre. And in like manner is it with the north and south signes, and their degrees : admit I would know where aboutes the 10. degrees of ♊ riseth because ♊ is north signe, I turne the *reete* till the 10. deg. thereof do cutte the horizon in the northeast quarter, and for his setting in northwest. In like manner the south degrees rise in the southeast quarter, and set in the southwest: take some paines and conceiue this Chapter well, and you shall haue a pleasant vse of your *Iewel*: you shall vnderstand it the better if you conferre it with other Chapters of the third booke that hang hereon, as hereafter will follow.

Chapter

Chapter 22.

Of the backe of the Iewel, *and his lineaments.*

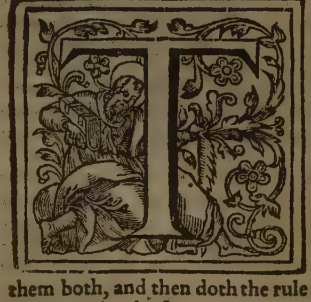
IN the backe of the *Iewel* I haue appointed the theoricke of the ſunne, and ſome one deuiſe or other within it, for ech man to make choiſe of by the 13. Chapter. The rule on the backſide ſerueth chiefly to take altitudes: the line hanging plumme from the handle, I call the perpendiculer or plumme line, and the line croſsing the ſame ſquare, which in taking altitudes lieth (or at leaſt muſt lie, if you do well) parallel to the horizon, I call the line of leuell. Looke more in the fourth Booke and laſt Chapter.

FINIS.

The third booke of the Mathematicall *Jewel*: gathered and ſet foorth by Iohn Blagraue *of Reading Gentleman: conteineth al the propoſitions, and conclusions* of Iohannes Stophlerus, Iohannes Sconerus, Iohannes Roijas, G. Friſius, or any other, written on their ſeuerall Aſtrolabes, ſet downe heere in the ſelfeſame order that Gemma Friſius hath done them on his Catholicon, but all of them applied to this Iewel, and altered to a more plaine and briefe Method, both in writing, working, and vnderſtanding, by reaſon of the Authors newy deuiſed *reete*, which performeth them fixed as redie, as by any tables, without any of thoſe tedious profers, or doubtfull aſſaies, which Gemma Friſius is driuen to vſe, by his *Curſor*, or *Brachiolum*: who alſo hath annexed diuerſe new additions to moſt of the Chapters.

Chapter 1.

How by this Iewel *to take the altitude of the Sunne, Moone, or Starres.*



THough this matter be too too wel knowne alreadie, euen to the common ſort: yet ſince other authors haue made it their firſt Chapter, I refuſe not to follow the ſame courſe. A degree in latin *Gradus*, is the 360. part of a circle: *Altitudo*, in Engliſh altitude, or height: the ſame in all Aſtronomical obſeruations, is taken by the degrees of a circle, or a relation vnto them. VVherefore to take the altitude of the Sunne, let hang the *Iewel* in your hand at libertie, turning the edge of the *Limbe* towards the ſunne, the rule on the backſide lying euen in the line of leuell, which line repreſenteth here your horiſon: then lift vp that ende of the rule next the ſunne (or put downe the other, all is one) vntill you may ſee the ſunne beames to peirce both the ſight holes, and looke what degree of the *Limbe* the rule cutteth, counted from the line leuell, the ſame is the Sunnes altitude for that inſtant. For ſtarres you muſt with one eye ſhut, looke through the greater ſight holes, made of purpoſe for ſtars, till you ſee the ſtarre thorow them both, and then doth the rule ſhew your altitude. Alſo a man may, if his ſight holes be too little, or the ſtarre dimme, take the ſtarre euen with the vpper edges of the ſights, ſo they be parallel to the holes, which of ſome is thought the beſt way. Further if your inſtrument be heauie, or your hand vncertaine, it is beſt to hange it by a naile on a tree, ſtaffe, or poſt, this taking of altitude will be much in vſe hereafter.

Note that when you take the altitude of the Sunne, Moone, or any ſtarre being in the Meridian circle, then is the ſame called the meridian altitude.

Chapter 2.

How to get or rather examine the Sunnes greateſt declination, and diſtance of the Tropickes, and thereby alſo to learne the latitude of any countrie.

Gemma Friſius.

THe Eclipticke lieth alwayes byas, or inclining to the equinoctiall, according to the ſunnes greateſt declination, which in theſe dayes is 23. degrees 30. minutes, or rather after late writers 23. degrees, 28. minutes, which to proue, take the meridian altitude of the ſunne in the higheſt of ſommer, being in the very Solſtice, and

and againe in the deepeſt of winter, being in the winter Solſtice. Deduct the leſſer meridian height, out of the greater, the remainder is the diſtance of the tropicks: halfe that, is the Sunnes greateſt declination. For example.

In the yeare 1579. about S. Barnabies day, becauſe the countrie folke account that the longeſt day in the yeare: for two or three dayes before, and after, I watched the ſunne comming to the ſouth, and there I tooke his higheſt altitude ech day, and I found that the 13. day of Iune the ſunne had the higheſt Meridian altitude, which was 62. degrees that I noted in my book. Then about ſaint Lucies day in winter, counted the ſhorteſt day in the yeare, I watcht the ſunnes loweſt meridian altitude, and found it the 13. of December to be 15. degrees. then of theſe two I ſubduct the leſſer vz. 15. out of 62. the greater: there reſteth 47. and that is the diſtance betweene the tropickes, the halfe of that vz. $23\frac{1}{2}$ is the greateſt declination of the ſunne, and ſo much doth the zodiacke decline from the equinoctiall, and as much doe the poles of the worlde, which are alſo the poles of the equinoctial, differ from the poles of the zodiacke.

The Declination of the Sonne Doth Differ

Heere muſt you note that this greateſt declination of the ſunne hath not alwayes beene found one, of ſeuerall authors at ſeueral times: for Ptolomeus & Ariſtarchus, Samius and Timochares, that were 400. yeares before him almoſt, did finde by obſeruation that this declination was 23. degrees, 51. minutes, and 20. ſec. and from their time hitherwards, it is founde to decreaſe by little and little. For *Mahometes Aratenſis* after Ptolomeus 749. yeares, found it 23 degrees 35. minutes: after him 420. yeares, Prophatius Iudeus 23. deg. 32. minutes. Thoſe of our times, as VVernerus, and Copernicus, haue found it 23. deg. and 28. minutes, and ſo is it thought to be at this time, of thoſe that haue made obſeruations with large inſtruments.

They that Dwell in temperate Zones.

But now by this declination is had the latitude of any place, verie commodiouſlie. For example: becauſe before I found the ſunnes loweſt meridian altitude 15. deg. adde thereto the ſunnes greateſt declination nowe knowne vz. 23. degrees. 30. minutes, it maketh 38. deg. 30. minutes, the equinoctials height aboue the horizon, which you ſhall deduct from the quadrant of a circle vz. 38. 30. out of 90. there reſteth 51. deg. 30. minutes, the height of the pole, or latitude at Reading, where I made the foreſaid obſeruation. But being made by ſmal inſtruments, I haue ſomwhat erred, for it is heere $51.\frac{2}{3}$. The contents of this Chapter ſerueth moſt truly as before, to all thoſe that dwell in the temperate zones, that is whoſe zenithes are betweene the tropicke and pole circle. But to thoſe that haue either tropicke in the zenith, the loweſt meridian altitude of the ſunne, being in the winter ſolſtice muſt be taken out of 90. & ſo reſteth the diſtance of the tropicks. And to thoſe that haue their zenith betweene the two tropickes, the two meridian altitudes taken in the ſolſtices, muſt be ioyned togither, and the ſumme amounting muſt be taken out of the ſemicircle vz. 180. and ſo reſteth againe the diſtance of the tropickes, whoſe halfe vz. the ſunnes greateſt declination being added to the ſunnes loweſt meridian altitude, maketh the eleuation of the equinoctial aboue any ſuch horizon, which being take (as before) out of 90. degrees, leaueth the poles eleuation. Likewiſe whoſe zenithes are in the colde zones, who haue the ſun continually aboue the horizon certaine dayes, there muſt you take the ſuns greateſt meridian altitude, being in the Solſtice, and likewiſe his left meridian altitude the ſame day (for the ſun commeth twiſe viſiblie in 24. houres, to the meridian euen as our north ſtars do) thoſe two meridian altitudes ioyned togither, make the whole diſtance of the tropickes, thoſe that haue either of the poles their zenith, there the higheſt meridian altitude, is the ſunnes greateſt declination, and thoſe that haue the pole circles zenith, the greateſt meridian altitude, in the ſommer Solſtice is the diſtance of the tropickes.

They that Dwell betwixt the 2. tropicks.

Blagraue. All theſe and many more you may learne by the very beholding of the *Iewel*, and might haue done if nothing had beene written thereof, for the *Iewel* being placed from latitude to latitude, as in the 2. Booke and 19. Chapter is ſhewed: you may reckon euen vpon the *limbe* all theſe altitudes aboue the *Finitor*, ſeuerally at pleaſure, for the Almicantares are had *Ipſo aſpectu*, and truely all the circulations of the globe, more readie then if you had the ſphere in your hand, and therefore reade well the laſt part of the ſecond booke, to vnderſtand euery part of your *Iewel*.

Chapter 3.

How by the theoricke on the backe of the Iewel, to get the ſunnes place or degree in the zodiacke any day.

Gemma Friſius 5.

SEeke the day propoſed in the circle of monethes, on the backſide of your *Iewel*, and thereto lay the rule which in the circle of ſignes adioyning, ſheweth the degree ſought for.

Example.

This preſent day being the 7. of Iune 1582. I would know where the ſunne is, vz. in what degree of the zodiacke, I reſort to the backe of my *Iewel*, and ſeeke in the *Limbe* of monethes fore Iune: and there the 7. day, as they be figured, where on I lay the rule which I finde to cutte in the *Limbe* of the ſignes, adioyning the 25. degree, and almoſt 40. minutes of Gemini, ſeruing to the beginning of the ſaid 7. day of Iune, which is the degree of the ſunne ſought for.

But here by the way you muſt note, that the circle of the yeare conteineth but 365. dayes, where as in truth it is 6. houres more verie neare, which is a quarter of a day, therefore when you make your theoricke, you muſt know to what yeare it is made, either the firſt, ſecond, or third after the leape yeare: that knowne, your theorick ſerueth exactly ynough for that yere to which it is made, but to the next yere you muſt adde a quarter of the next day following to your day propoſed, and then take the degree of the zodiacke ſeruing that, to the ſecond yeare, take halfe the day following, to the third three quarters, and then the fourth is the yeare of the theoricke againe, and needeth nothing to be added: deuide the yeare of our Lord by 4. and if there remaine nothing it is leape yeare, if one two or three, as neuer it is aboue, it ſheweth the yeares paſt from the leape yeare.

Example.

This yere 1582. deuide 82. by 4. (for always the M. & C. years are leapyears) there reſteth two, wherby I

know that it is the second from the leape yeare, so that if my theoricke were made for the first yeare, then this being the second yeare, I adde to euery day, a quarter of the day following through the whole yeare, and so of the rest. These sixe houres foure times gathered make a day, and therefore euerie fourth yeare February hath 29. dayes, and then is called the leape yeare, in latin *Bissextus* or *annus intercalaris*, because a day is then put in betweene, other minutes wanting are not here to be regarded.

Chapter 4.

How to finde the sunnes declination for euery day in the yeare, and also the declination of euery part of the ecliptick.

Gemma Frisius.

WHat the sunnes greatest declination is, it is said in the 2. Chapter. In like manner, euerie degree of the zodiacke hath his seuerall declination denominated by the parallel, cutting the same deg. wherefore the ecliptick line being drawne on the *Mater*, and deuided as in the 4. Booke, and 6. Chapter is shewed: Learne by the last Chapt. the sunnes degree in the zodiacke, for the time proposed, seeke the same degree on the ecliptick line, and then doth the parallel crosing the same, shew in the *Limbe* (or otherwise reconed from the quinoctial) the declination sought for. *Example.*

The first of may this yeare 1582. I would knowe the sunnes declination: by the last Chapter I finde the sunne to be in the 20. degree, and almost an halfe of ♉ I seeke that degree on the ecliptick of the *Mater*, and there do I see to crosse the $18.\frac{1}{2}$. parallel, reckoned from the quinoctiall, and because the same parallel lieth towards the pole arricke, or north pole from the quinoctiall, I conclude the sunne declineth $18.\frac{1}{2}$ degrees northwards, and so may you see the declination of any degree of the ecliptick, whither the sunne be there or not: if the ecliptick be not on your *mater*, or be vndeuided, the rule or *Finitor* may supplie it.

How to do the same a new way by the zodiacke of my Reete.

Blagraue. Lay the *Label* on any degree in the zodiacke, and his degrees reckoned inwards from the *Limbe*, shew your desire. *Example.*

The last of March 1582. the sunne being in the 20. deg. 26. minute of ♈, I seeke the same degree in the zodiacke of the *reete*, and thereto lay the *Label*: then reckoning the degrees of the *Label*, betweene the *Limbe* and that degree of the zodiacke, I finde 8. degrees and better, the declination thereof: and because ♈ is a North signe it declineth North. Note that if your *Label* be not deuided, you neede but turne about the *Reete* till the zodiacks degree proposed, do cut the noone line, or axtree line, and either of them shall supplie his want.

Chapter 5.

How to finde the latitude or poles eleuation, any day proposed in any place, or countrie what soeuer.

Gemma Frisius.

THe latitude or poles eleuation, are in effect all one, and what they are is shewed in the first Booke 11. Chapt. first by the 3. Chapter seeke the degree of the sunne, for the day proposed, and by the 4. Chapt. the sunnes declination, then take the meridian altitude by the first, and reckon the same among the almicantares, from the *Finitor* vpwards, turning about the *Reete* till the same almicantare do touch in the *limbe*, and that rightwards from the pole articke, the sunnes parallel of declination: and so doth the *Finitor* stande fixed to the latitude of that place: the degrees in the *Limbe* betweene the *Finitor* and the pole articke, sheweth the eleuation thereof aboue the horizon of that countrie, or place.

Example. The 10. of Aprill 1582. the sunne being in ♉, by the 3. and his declination $11\frac{2}{3}$. by the 4. I tooke his meridian altitude 50. deg. which done, I told out the 50. almicantare, and turned about the *reete* til the said 50. almicantare did meete the $11\frac{2}{3}$ parallel (reckoned towards the north pole) on the *limbe*, and there the *reete* fixed, I reckon on the *Limbe* the degrees betweene the *Finitor* and the pole, or betweene the zenith and the quinoctiall, which are alwayes equall, I finde $51\frac{2}{3}$ degrees, which is the height of the pole, or latitude at Reading. Note that in all workings for the most part, the zenith point of the *reete* must be aboue the quinoctiall towards the North pole.

You may do the same another way without the *Iewel*, thus: if the declination of the sunne be north, subduct the same from the meridian altitude, as here it was $11\frac{2}{3}$, which taken out of 50. the remaine videl. $38\frac{1}{3}$ is the equinoctials height aboue the horizon, which alwayes subducted from 90. leaueth the latitude vz $51\frac{2}{3}$. But if the declination be south, adde the same to the meridian altitude, and so haue you the equinoctials, height which taken from 90. leaueth likewise the latitude.

Chapter 6.

How to know what it is a clocke at any time the sunne shining, and in any region in the world.

Gemma Frisius. 30.

I Cannot choose but set downe this Chapt. next. because it is one of the chiefest that any yong beginner can delight in, and by my *Iewel* is one of the easiest where, in Gemma F. instrument, it was one of the hardest, and

and therefore he appointed it the 30. Chapter, becauſe a man ſhould be firſt well acquainted with his inſtrument. The latitude of your place or abiding, being firſt had by the 5. or otherwiſe, as ſhalbe ſhewed in other Chapters following, you muſt get the ſunnes declination for the day propoſed, by the 4. and then at the inſtant that you would know the houre, take the ſunnes altitude by the firſt: which done, the *Finitor* being ſet to the latitude reckon the ſunnes altitude ſo taken amongſt the almicantares, and marke where his parallel of declination cutteth the ſame almicantare, for there the houreline paſsing by, doth ſhew the houre and deg. euerie deg. being 4. minutes, thus in briefe always the altitude being taken the houreline paſsing through the croſsing of the Almicantare, and the ſunnes parallel is your deſire.

Blagraue. As oft as I looke what it is a clocke by my *Iewel*, and ſee with what facilitie, certaintie, and redineſſe for euerie countrie I doe it, ouer that I was wont by Gemma Friſius inſtrument, with his Curſor and Brachulum, I can not but meruaile that hee and his ſonne Cornelius G. coulde bee content with ſo troubleſome a practiſe, which trulie I lothed euen vpon the firſt ſight, which not onely in working this Chapt. but alſo in moſt of their whole booke is verie comberſome, although in ſome Chapter more then in other, yet is Gemma Friſius to be excuſed, becauſe he was the inuentor. *Facilius enim eſt inuentu addere quam de nouo componere.*

Example. The firſt day of October 1580. in the morning I went foorth of my ſtudie at our manſion houſe at Bulmerſh by Reading, where I was writing the firſt copie of this propoſition at that preſent inſtant. The latitude being there $51\frac{2}{3}$ degrees, and at the ſame time the ſunne being in the 23. deg. 8. minutes of ♎, his declination by the 4. was 9. degrees ſouthwards, and 6. minutes, all theſe things to him that vſeth his *Iewel* daily will alwayes be in memory, I ſay, I went forth then, and turning the edge of my *Iewel* to the ſunne, I founde his altitude 12. degrees by the firſt, which is as much to ſay, as the ſunne was that inſtant in the 12. almicantare, wherefore, by the ſecond booke 19. Chapter, ſetting the *Finitor* to our latitude vz. $51\frac{2}{3}$ deg. I marked where the 12. almicantare reconed from the *finitor*, did cut the $9\frac{6}{60}$ parallel, reconed from the equinoctiall line towards the ſouth pole, for that the ſunnes declination was ſouth, and there did the houreline that croſſed this interſection ſhew me that it was 3. deg. paſt 8 of the clocke, that is 8. of the clocke, and 12. minutes paſt. For euerie degree is 4. minutes in reconing the houre at all times, though euerie degree in euerie other reſpect hath 60. minutes, and euerie minute 60. ſeconds, and euery ſecond 6. thirds &c. vnto tenthes. It was 12. minutes paſt 8. and therefore time to go to breakfaſt, for him that lay not laſt a bedde: I made haſt into the hall where I found my companions at it, and ſo ſharpe ſet, that had not my *Iewel* beene readier then Gemma Friſius Aſtrolabe, I had loſt my breakefaſt with looking what it was a clocke, and therefore I had great cauſe to commend it at that time.

But what did I ſee more, euen the azimuth that the ſunne was in at that inſtant, alſo croſsing the interſection of the ſunnes parallel, and almicantare, which being reckoned from the zenith line, did ſhewe me that the ſunne was in the $32\frac{1}{2}$ vertical circle reckoned from the Eaſt, the azimuthes indeed do repreſent, as it were the points of the compaſſe, and before the compaſſe found, men failed thereby, and therfore if you did diſtinguiſh them into the points of the compaſſe, by ſome notable difference, then might you ſee at all times on what point the ſunne, Moone, or any ſtarre were without helpe of the lodeſtone, there be 32. points, by which deuide 360. and the quotient ſheweth $11\frac{8}{60}$ degrees, ſeruing euerie point ſeuerally, but this ſerueth to no great vſe but onely on the ſea.

Chapter 7.

The latitude of any place knowne, how to get the declination of the ſunne, or any ſtarre, planet, or comet, by obſeruation.

THe latitude knowne, ſubduct that out of 90. there reſteth alwayes the height of the equinoctiall in that horizon, for the latitude and the equinoctials height, are one the complement to the other, they both making 90. degrees. This knowne, take the meridian altitude of any ſtarre or planet by the firſt Chapter, which if it be found greater then the equinoctials height, then to vs that dwell on this ſide of the equinoctial, the ſtarre ſhalbe north declining, if leſſe, it ſhalbe ſouth: therefore take the leſſer height out of the greater, the remaine, it is your deſire.

Example. Heere at Reading the latitude being $51\frac{2}{3}$. the complement of 90. is $38\frac{1}{3}$. degrees, the equinoctials height. I tooke the meridian altitude of the great ſtarre called Arcturus, or bootes, and found it $60\frac{1}{3}$ degrees, out of $60\frac{2}{3}$. there reſteth $22\frac{1}{3}$ degrees, ſo much is the declination of Arcturus from the equinoctiall, and that, northwards, becauſe his height was greater then the equinoctials, and ſo may you do for the declination of any ſtarre, plannet, comet, or the ſunne.

But there are a great many ſtarres that to vs neuer come at the ſouth, becauſe they neuer come beyond the zenith, which are thoſe whoſe diſtance from the pole, is either leſſe, or equall to the diſtance betweene the zenith and the pole. The diſtance betweene the pole and the zenith, is alwayes equall to the equinoctials height, wherefore the meridian height of ſuch ſtarres may be northwards, twiſe taken, once aboue the pole and againe vnder the pole. For the declination of theſe, take the latitude out of the greateſt meridian altitude, and the remainer out of 90. ſo reſteth your deſire. But if you will worke by his leſſer meridian altitude, ſubduct it out of the latitude, and the remainder out of 90. there reſteth then the declination ſought for. Againe if you liſt, ſubduct the leſſer meridian altitude out of the greater, and part the remainder in halfe, and ſubduct that halfe from 90. the ſame declination appeareth againe.

There be other ſtarres which come paſt the zenith, and yet neuer ſet: their declination may be had both wayes. The *Iewel* it ſelfe yeldeth ſo plaine demonſtration thereof, that it needeth no example, for the *finitor* being at the latitude, the parallels ſhew what ſtars may ſet, or ſet not: riſe or not riſe. I take the leſſe, vz. $38\frac{1}{3}$ in that countrie.

To do the same, the starre being in any place of the skie by obseruation and helpe of the Iewel.

Blagraue. Place your *Iewel* to lie leuell or flatte with the horizon on a stoole, poste, or otherwise, so that the line of leuell lie in the meridian vz. iust north and south, which you may doe by helpe of a diallneedle, rectified or otherwise, as shalbe shewed in the 33. Chapter: this done turne about the rule till you may see the starre desired, euen with your sights, and then marke what degree the rule cutteth in the *Limbe*, and reckon him from the nooneline, for that sheweth the azimuth the starre is in: this done, take vp your *Iewel* presently and take the altitude of the starre. Now the altitude and the azimuth being had both at one instant, set the *finitor* to the latitude, and seeke where the like azimuth, & almicantare do crosse ech other, the parallel of the *Mater* cutting the same crossing, sheweth the declination of the starre, being numbred from the equinoctial.

Example. I went one night to make this experience of the great starre vnder Orion, called *Canis maior* the great dogge, when my *Iewel* was laide flatte with the horizon on a stoole, and the nooneline euen with the meridian, which I had first drawne in the day time vppon the stoole, then turning about the rule towards the starre, I founde that my sightes were not apt and heigh ynough for my purpose. wherefore I hanged a plumline, or corde somewhat VVest from the Starre, so that I might perceiue the same line or corde thorow the sights, then I stayed vntill the starre going forwards was come, so that I might see thorow the sight holes of my rule euen with the corde, then I marked what degree in the *Limbe* the rule there cut, I found it 39. degrees from the noone line, this number kept I in minde for the azimuth, and speedily I tooke vp my *Iewel*, and tooke the Starres altitude, which that instant I founde to be 14. degrees. This done, I set the *Finitor* to our latitude vz. 51 $\frac{2}{3}$ and sought where the 39. azimuth, and the 14. almicantare did crosse, and there I found the 16. parallel to cut them: whereby I concluded that the declination of *Canis maior* was 16. degrees, and that southwards, because I found the said parallel on the south side of thequinoctial, & what more might I there see, the houreline cutting there with the parallel, did shew me his houre distance from the south, whereby I might haue knowne what it had beene a clocke, and his right ascention also, as shalbe shewed in the 17. and 26. Chapters. Such is the redinesse of this *Iewel*, that he would clappe thre or 4. of Gemma Frisius Chapt. into one, if I would suffer him, and sometimes doth whether I will or no, except I should make two Chapters of one thing, which I neede not for lacke of matter, as some haue done, that coyne a great many Chapters without substance.

Chapter 8.

How the latitude or poles eleuation may be had in any region by the starres that neuer set.

TO those onely that dwell vnder thequinoctiall, all the starres of the firmament do both rise and set euerie 24. houres: but to those that haue either pole eleuated, by howe much the more it is eleuated, by so much the more number of starres are continually aboue the horizon, and as many continually vnder, in somuch that where the pole is zenith, the one halfe is euer aboue, the other vnder. By those starres that are alwayes aboue any horizon may the latitude be thus found.

Take both the meridian altitudes of the starre vz. the highest and lowest altitudes in the meridian, as in the 7. there will be 12. houres betweene these altitudes, and yet oftentimes it may be done in a winters night, otherwise you must haue certaine monethes space betweene. Adde the two altitudes, the halfe thereof is the poles eleuation.

Take here Gemma Frisius example. He saith at Louane the 13. of December 1547. about sixe of the clock at night, he did diligently obserue the greatest altitude of the starre in the taile of *Vrsa minor*, called *Cynosura* which we call the pole starre, to be 53. degrees, 58. minutes, the next day about sixe of the clocke in the morning he obserued his meridian altitude, and found it 47. deg. 43. min. these two added make 101. degrees 41. min. the halfe hereof vz. 50. degrees 50. minutes is the height of the pole at *Louanium*.

Blagraue. But the cause why I tooke Gemma Frisius example, is to shew you that it appeareth by his obseruation, and the middle part of the Chapter last before, that the starre which the common sort and vnlearned do take for the pole of the worlde is distant 3. degrees 8. minutes from the pole, the pole it selfe being no starre, but onely a point imagined 90. degrees distant from ech part of thequinoctiall. Farther you must note that this serueth but for starres equall or lesse distant from the pole, then the zenith: but where as the one meridian altitude shalbe north from the zenith, and the other south, adde them as before, and halfe the product is the declination of the starre, subduct that out of the greatest altitude there resteth thequinoctials height, which subducted from 90. leaueth the latitude.

Chapter 9.

The latitude knowne, how to finde what day of the moneth it is, though it were lost, as they say, by the sunne shining at noone.

IN the 3. Chapter is shewed by the theoricke to get the sunnes place by the day giuen. But here we suppose the day vnknowne: or else admit we would examine the account made by Alphosus tables. First gette the latitude as before, then take the meridian altitude of the sunne, and thereby get his declination by the 7. and whether it be northwards, or southwards: if therefore the declination be north, reckon it on the *Iewel* among the parallels towards the north pole: but if southwards then among the south parallels, and the same parallel so reckoned from thequinoctiall, shall cut thecliptick in the degree that the sunne is in at that instant.

Example. In Autumne 1580. on a day vnknowne for want of an Almanacke, I tooke the meridian altitude

tude of the ſun 32.deg. ſo that by the 7. I found his declination ſouth 9.deg. Therefore among the parallels ſouthwards I reckon 9. I finde that the 9.parallel doth cutte the $22\frac{1}{2}$ of ♎,or ♓, but becauſe it is in Autumne, therefore it muſt needs be of ♎, if you doubted whether it were Autumne or ſpring, obſerue the altitude againe a day or two after,and if it be leſſe it is Autumne,if greater,the ſpring. But now hauing the degree of the ſunne in the zodiack, to finde the day of the moneth it is but *Vice verſa* to the 3. Chapt. and 4.for euen as in the 3.hauing the day, you ſeeke the ſunnes deg. ſo heere hauing the deg. you may in the circle of monethes of the theoricke, ſee the day anſwerable accordinglie, thus: ſeeke in the theoricke $22\frac{1}{2}$ deg.of ♎, and there ſhall you ſee to anſwere the 5.day of October your deſire. *Hoc rudiori minerua.*

But this obſeruation although it be excellent, by which both the quantitie of the yeare,and ſunnes motion hath beene by old practiſers obtained, yet doth it require inſtruments verie large, and for all that about the Solſtices it is ſcarſe exquiſite,becauſe then the dayly aſcenſe of the ſunne cannot eaſily be diſcerned by inſtruments,by reaſon of the tranſuerſe ſight of the zodiacke.

Blagraue. I will ſhewe you another as reddie way, or reddier by my *Reete*, and the rather becauſe in ſmall inſtruments thecliptick line may be either left out,or not exactly diuided in the *Mater*,and is not much different from my addition in the 4. Chapt. For hauing taken the altitude,and founde the declination as before, then reckon that declination on the *Label* from the *Limbe* inwards, vz. 9.becauſe it is Autumne: let the *Label* runne ouer the autumnall ſignes,which are ♎,♏ and ♐, vntill the ſame 9.degree doe touch or croſſe the zodiack,& you ſhal finde that it wil light on the $22\frac{1}{2}$ deg. of ♎,euen as before,and if the *Label* be not deuided, turne the autumnall ſignes on the nooneline, and you ſhall finde the $22\frac{1}{2}$ of ♎ to touch the 9.deg.reckoned on the noone line from the *Limbe*: if it were for the ſpring time,then you ſhould take ♈ ♉ and ♊, if in winter ♑ ♒ ♓,in ſommer ♋ ♌ ♍,&c.

Further you ſhall vnderſtand that though Gemma Friſius appointeth this to be done, the ſunne being in the meridian, yet by my addition in the 7. Chapter,you may do it any time of the day, and as well or better towards night then at noone. For by the Azimuth and altitude of the ſunne, you may get his declination, as I there ſhewed you to get the declination of the ſtarre, and ſomwhat more eaſie is it in the ſunne: for you neede but hange a plum line in your hand betweene the ſunne and the *Iewel*,if the ſights be not long ynough, and then turne the rule about till the ſhade of the line fall equall with the fiduciall line of the rule.

Chapter 10.

To finde the right aſcenſion for any portion of the eclipticke,and what degree of the Equinoctiall doth coaſcend,or riſe togither with euery degree of thecliptick in a right ſphere.

Gemma Friſius. 12.

THecliptickeby reaſon of his oblique ſite to thequinoctiall, doth continuallie change his ſcituation in euery horizon: ſo that ſomtimes he is ſcituate ſomwhat right, and then goeth he ſlower, ſomtime more oblique, and then goeth he ſwifter. But thequinoctiall becauſe in euerie ſeuerall horizon, he keepeth one inclination, and forme of his angles in his motion, there doth alwayes riſe in equall time equall portions thereof: wherefore Authors haue meaſured the motion of thecliptick by thequinoctial partes. Therefore the portion of the equinoctiall, which riſeth with any part of thecliptike is called *Aſſenſio* in latin, in Engliſh a riſing,or aſcention. In a right ſphere, this riſing is called *Aſcenſio recta*, right aſcention: in an oblique ſphere. *Aſcenſio obliqua*, oblique or byas aſcention, and beginneth his number where o. in ♈ cutteth the Equinoctiall. the hed of Aries.

This matter is eaſie by the *Iewel*. For hanging it by the handle or equinoctiall line of the *Mater*, the axtree-line repreſenteth the right horizon. And the meridians cutting euerie degree of thecliptick, if you follow them to thequinoctiall line (whereto the rule with his numbers muſt be ſet) do expreſſe what degrees of the one do riſe with the degrees of the other. Note alſo that euery meridian is a right horizon to ſome place or other.

Example. Take the *Iewel* in your hande, and ſet the rule to thequinoctiall line, becauſe of the diuiſions, and then if for the right aſcention of the 5.degree of ♉, you follow the meridian, cutting the ſame degree of the eclipticke line drawne on the *Mater*, till you come to the Equinoctiall: there the rule ſheweth you $32\frac{2}{3}$ deg. and a little better,which is the right aſcention of 5.deg.in ♉. And for the 5.degree of ♍. The ſame meridian ſheweth in the rule $212\frac{2}{3}$ degrees and better, for the vppermoſt numbers of the rule, ſerue the vppermoſt carectars of thecliptick line vz. from ♑ to ♋, and the lowermoſt the other vz. from ♋ to ♑. And now it is eaſie to know how many degrees of thequinoctial riſe with any whole portion of thecliptick: as for example, with the whole ſigne of ♉, the two meridians comprehending it, do ſhew in the rule 29.degrees 54. minutes of thequinoctiall.

Chapter 11.

The ſame more compendiouſly by the Reete.

Gemma Friſius. 13.

PLace the *Reete* ſo,that o.in ♈ of the zodiacke touch the north pole in the *Mater*, and o. in ♎ the ſouth: and now the *Limbe* heere repreſenting thequinoctiall, as I haue ſhewed in the 2.Booke 20.Chapt. is deuided accordingly, the numbers beginning from the ſaid interſection at o. ♈ in the centre being now the pole or poles of the worlde. It muſt needs be therefore that euerie line imagined from the centre to the,

Limbe

Limbe representeth a meridian, which cutting the zodiack of the *Reete* performeth the scope of the last Chap. For lay the *Label* on any degree of the zodiacke, and it presently sheweth in the *Limbe* his right ascention: this needeth no example.

Opposite signes haue equall ascensions.

Note that opposite signes and also signes equally distant from the equinoctiall points do ascende in a righe spheare in equall time as ♈ ♓ ♎ and ♍ likewise ♉ ♌ ♏ and ♒: also ♊, ♑, ♐, ♑.

Right ascension et culminations.

Note also being that euerie Meridian is a right horison to some place, as in the last cap. I sayd, therefore the like degrees of the ecliptick and the equinoctial must needes cut togither the meridian of any place as do cut in any right horison, but then are not called right ascention, but cœlimediation or *Culmination*, whereby you see that the right ascention and *mediation* or *Culmination* are all one in substance: but yet to say the trueth, the right ascension is properly the degree of the equinoctiall, the Culmination is the degree of the ecliptike coascending the right horizon with any starre.

Gemma Frisius 14. Contrariwise to any right ascention proposed any man may gather the degrees of the ecliptick coascending performed, *visa versa*.

Chapter 12.

What point of the ecliptick it is, as well in the first quadrant as in the rest also, that hath the greatest difference betweene the arch of the ecliptick, and the arch of the equinoctiall coascending with him.

Gemma Frisius 15.

THis working requireth heede. Lay the rule vpon the pole circle of the *mater*, mouing it to and fro thereon, in such wise that the pole circle do cut like degrees in the rule numbred from the centre, as the rule doth cut in the *Limbe* numbred from the equinoctiall, and then reckon the degrees in the *Limbe*, from the pole to the rule, the same is the declination or the part sought for, then by the declination so known, the point of the ecliptick is had by the 9. Chapter.

Example. Let the pole circle (to auoide profers for breuities sake) cut $73\frac{1}{4}$ deg. in the rule, the same number you shal finde the rule to cutte in the *Limbe*. Then betweene the pole & the rule reckoned on the *Limb*, are $16\frac{3}{4}$ degrees, the declination of the point sought for. Therefore by the 9. to that declination, there answereth $16\frac{1}{4}$ degrees of the ecliptick numbred from ♈ in ♈ or ♎, so that in the first quadrant it lighteth in the $16\frac{1}{4}$ degrees of ♉ in the second, the $13\frac{3}{4}$ of ♌ in the third, $16\frac{1}{4}$ of ♏, in the fourth, $13\frac{3}{4}$ of ♒. now because the right ascension of the $16\frac{1}{4}$ deg. of ♉ is $43\frac{3}{4}$ deg. of the equinoctiall, and that that part or degree of the ecliptick is distant from ♈ in ♈ $46\frac{1}{4}$ deg. subduct the lesse from the greater, there resteth $2\frac{3}{4}$ deg. almost which is the greatest difference betweene the arches of the ecliptick and the equinoctial in the assensions of the right sphere which hapeneth in the said 4. places.

Note that if the greatest declination of the sunne vz. $23\frac{28}{60}$ deg. shoulde in time alter to be more or lesse as it hath in time beene found lesse and lesse by *Ptolomeus*, *Vernerus*, *Copernicus* and others, then would the number afore vz. $73\frac{1}{4}$ deg. alter by reason the pole circle then altereth also, or else not.

Chapter 13.

Of the difference of ascensions.

Gemma Frisius 16.

IT appeareth by the last Chap. that the greatest inequalitie of ascension in a right sphere, cannot be aboue $2\frac{1}{3}$ degrees betweene the rising of the degrees of the quinoctiall and the ecliptick; but in an oblique horizon there hapeneth great varietie and difference, because the ecliptick and the horizon make for greater mutations of angles, and inclinations, then in a right sphere. Whereby the signe ♈ hath a farre deale lesse ascention in regions, declining to the North, then in a right sphere: and contrariwise ♎ far greater: So hath ♉ lesse then ♍, and ♊ then ♑, which in a right sphere haue equal ascentions. The cause is for that those rise aboue the horizon in a more oblique scituation, and these in a more right, insomuch that the sixe signes from the beginning of ♋ vnto thend of ♑ are called right ascending, the rest oblique ascending. And the more the sphere is bending towards the poles, the greater is this diuersitie: this difference of ascentions, either in excesse or decrease, from those of the right sphere, is called *Ascensionum differentia* (that is) the difference of ascensions, yet looke how much wanteth to signes oblique, ascending of their right ascensions, so much againe the opposite signes right ascending do encrease: so that the right ascentions of two opposite signes are equall to the oblique ascensions of the same signes taken togither. But now to the matter.

How to finde the difference of ascensions, place the *Finitor* to the latitude, then seeke in the ecliptick line that degree whose ascensionall difference you require, and followe the parallel, cutting that degree vnto the *Finitor*, marke what meridian cutteth the *Finitor* there with the same parallel, looke howe many degrees distant that meridian is from the axtree line, so many is the difference of ascention of that degree of the ecliptick.

Example. I would know the ascensionall difference of the beginning of ♉, I place the *Finitor* to the latitude vz. $51\frac{2}{3}$ here at Reading: then following the parallel, cutting ♈ in ♉ vnto the *Finitor*, I finde betweene the axtree line & the same point of the *Finitor* $14\frac{5}{60}$ meridians, therefore I conclude that the difference of ascension of ♈ in ♉ is 14. degrees, 5. minutes. And becaus ♉ is a signe oblique ascending (as is said) I say that he riseth so much sooner in our horizon then in a right horizon, as 14. deg. 5. min. commeth to. The like diuersitie of ascension hath the beginning of ♌, which is opposite to ♉, but that you must take away the difference

rence from the right aſcenſion in the firſt, where in this you muſt adde it, and ſo is it in all oppoſite ſignes and therefore to ſaue labour, the one being had the oppoſite is knowne.

Chapter 14.

The ſame very plainely by the Reete.

Gemma Friſius 17.

YOur horizon knowne by the 2. Booke 22. Chapt. If you would know the aſcentionall difference of any degree of the North ſignes, lay the ſame degree to cut on the northeaſt quarter of your horizon, and the rule thereto, and then numbring on the *Limbe* the diſtance betweene the rule ſo placed, and theaſt, or 6. of the clocke line, the ſame is your deſire. If you ſeeke this difference for ſouth ſignes, you muſt lay the degree on the ſouth eaſt part of your horizon, and then doe as before, but you may as is ſaide, to ſaue labour, know by the one halfe the oppoſites, yea by one quarter the whole for this matter, if you take them alike from 0. in ♈ and ♎ for ♓ ♈ ♍ and ♎ haue like difference, ♒ ♉ ♏ and ♌, ſo ♋ ♐ ♑ and ♊, but not in like degrees as the oppoſites haue.

Chapter 15.

To know the oblique aſcenſions.

Gemma Friſius 18.

BY the 11. and 12. you learned to finde the right aſcenſion of any part of the zodiacke, and by the 13. the difference of aſcentions, theſe knowne, then to the right aſcentions of the ſouth ſignes, add the difference, and from the right aſcentions of north ſignes, take the difference of aſcention, and ſo haue you your deſire.

Example. The right aſcen. of the 4. deg. of ♊ by the 11. & 12. is 62. degrees, the difference by the 13. is 28. deg. 18. minutes: now becauſe ♊ is a north ſigne, I ſubduct the difference vz. $28\frac{18}{60}$ out of 62. the right aſcenſion, there reſteth 33. deg. 42. minutes the oblique aſcenſion. Likewiſe the right aſcenſion of his oppoſite deg. vz. the 4. of ♐ is 242. to it I adde the difference vz. 28. 18. there commeth 270. deg. 18. minutes, the oblique aſcenſion, and ſo may you do for euerie eleuation or latitude.

Theſe preceps though they ſhew barren, yet haue they great vſes in dimenſions of times, and inquiſions of the heauenly motions.

Chapter 16.

Of deſcentions both right and oblique, that is, what degree of the equinoctiall doth deſcend with the ecliptick.

Gemma Friſius 19.

TRuely the *Iewel* it ſelfe ſheweth it, and therefore I will not ſtand vppon it, you muſt worke for them in the weſt parts of the horizon, as before in the 14. Chapter you did on theaſt, the aſcenſions and deſcenſions in a right ſphere are all one, and the difference in the oblique are all one, onely in this it altereth, that if you added the difference for the oblique aſcenſion as in the 15. you muſt ſubſtract it for the deſcention, and ſo contrariwiſe.

A briefe rule. Adde 180. vnto the oblique aſcenſion of the oppoſite degree to the degree propoſed, and ſo haue your deſire.

Example. For the oblique deſcenſion of the 4. of ♊, adde 180. to the oblique aſcenſion of the 4. of ♐, which is 270. degrees 18. minutes, as before, it maketh 450. 18. minutes, the oblique deſcenſion of the 4. in ♊ if it had not exceeded 360. But now you muſt out of this vz. 450. 18. minutes, caſt 360. the remaine vz. 90. deg. 18. minutes is the deſcenſion ſought for.

Chapter 17.

The longitude and latitude of any ſtarres propoſed, to know their right or oblique aſcention, and how much they decline from the equinoctiall, and how to place ſtarres in the Mater *of the* Iewel.

Gemma Friſius 20.

HEere Gemma Friſius burſteth out in theſe words. This inſtrument, ſaith he, hath ſuch aboundant and wonderful vſe, that I ſcarſe know to ſet it downe orderly, and therefore am forced oftentimes to reduce many things into one Chapter. How then (gentle reader) ſhall my poore capacitie being euerie way too much inferior to Gemma Friſius, ſet downe and performe ſo great a charge orderly, as my *Iewel* caſteth vpon me farre ſurmounting the other inſtrument, and well the worſe, being, that this wrangling world yeldeth me, time but by ſnatches.

But to the matter: ſet the *Finitor* euen with the ecliptick line of the *Mater*, and ſo do the azimuthes repreſent the longitudes, and the almicantares the latitudes of the ecliptick, therefore reckon the longitudes and latitudes of your ſtarre, which in diuerſe tables you may haue amongſt them: looke where they croſſe, there is the ſtarres place in the *Mater*, then marke what meridian and parallel of the *mater*, doe croſſe the ſame place of the ſtarre ſo founde, the one ſheweth his right aſcention, as in the 10. and the other his declination as in the fourth.

Example

Example. The faire red ſtar of the firſt light of the nature of ♂ called *Oculus tauri*, the buls eye, riſing alwayes to ſight about 2. perches vnder the ſeuen ſtarres: This ſtar I finde by Stadius tables, who is one of the neweſt writers, his longitude to be 63. degrees, 40. min. or in ♊ 3. deg. 40. min. all is one, and his latitude 5. deg. & 10. min. Southwards, this knowen, I ſet the *Finitor* to the Ecliptike lyne, ſo that the Zenith be towardes the South pole, becauſe the ſtarres latitude is South. Then on the *Finitor* or Eclipticke, which heere are all one frō ♈ towardes ♋, I reckon the ſtarres longitude, vz. 63. degrees 40. min. or the 3 deg. 40. min. of ♊, and in the azimuth iſſuing from that pont of the Eclipticke, I number his latitude, vz. 5. degrees 10. min. in the ſame point, that is to ſay, where the $63\frac{40}{60}$ azimuth, and the $5\frac{10}{60}$ almicantare do croſſe ech other on the *mater*, is the ſtarres place, and there may you graue him in and write his name: but becauſe in ſmall inſtruments it would hurt the worke. and alſo for that the ſtarres do remoue in 100. yeares almoſt a degree, therefore make but a pricke with yncke for the time being, and then turne away the *Finitor* vnto the latitude vz. $51\frac{2}{3}$ deg. being our eleuation heere at Readinge. Now the rule beeing ſette to the equinoctiall may you ſee the $62\frac{1}{2}$ meridian, cutting the ſaid prick or ſtar ſo placed, which ſheweth his right aſc. to be 62. deg. 30. min and the $15\frac{5}{8}$ parallel ſhewing his declination to be 15. deg. 50. min. & that towards the north from the equinoctial though he were ſouth from the eclipticke, laſtly for his difference of aſcenſion, you may eaſily know as in the 13. by following the ſtarres parrallel to the *Finitor*, and there take the number of the hourelines to the axtree line which here are 21. and better, by the which and the 15. Capt. you may gather his oblique aſcenſion. For becauſe the ſtarre is on the north part of the equinoctiall, therefore ſubtract the difference vz. 21. from the right aſcention before found vz. 62. deg. 30. minutes and there reſteth 41. degrees, 30. minutes, the oblique aſcenſion: but if you adde the difference vz. 21. vnto the right aſcention vz. 61. 30 thereof commeth 92. degrees 30. minutes, the oblique aſcenſion. But if it happen ſo that the ſtarres parallel touch not the *Finitor* then being a north ſtarre, he neuer ſetteth in that region, or being a ſouth ſtarre, he neuer riſeth there.

Chapter 18.

The declination of fixed ſtarres propoſed with their latitude, which neuer altereth, how to finde their longitude in the zodiacke.

Gemma Friſius. 21.

THe like Hipotheſis did Ptolomeus vſe, & before him Hipparchus Samius, whereby they found that the ſphere of the fixed ſtarres, had alſo a motion contrary to the firſt mouer, and that it is perfourmed according to the motion of the Zodiacke, and about his poles. For inſomuch as the latitude of all the fixed ſtarres from the Eclipticke, hath alwayes beene found one, and neuer altering, both of old writers and alſo of thoſe which now do obſerue the motions out of the heauen it ſelfe, and that it is moſt certaine that the ſtarres do continually goe forwards (from the Equinoctiall points, deſcribing circles parallell to the Eclipticke) they cannot therefore performe thoſe motions vpon any other then his poles. And hereby it commeth to paſſe, that although they be alwayes of like diſtance from the Eclipticke, yet they come neere or depart further off from the Equinoctiall.

It is ſhewed in the 7. Chapter how to get their declination from the equinoctiall: their latitude may be taken out of Ptolomeus tables, or any other, becauſe they neuer chaunge. Let vs therefore take an example out of Ptolomeus, who ſaith that Timochares which liued 432. yeares before him, did obſerue the ſtarre called Spica, in his time to be declining north from the equinoctial 1. deg. $\frac{2}{5}$ that is 24. minutes, but in the time of Ptolomeus, he was ſouth from the equinoctiall halfe a degree, my deſire is to knowe the true places of Spica, that is his longitude & latitude for both thoſe times propoſed. The latitude of Spica is 2. degrees ſouth from the eclipticke, therefore I place the *Finitor* to the eclipticke, the zenith towards the ſouth pole of the *mater*, for that the latitude is ſouth: and there do I note where the latitude of Spica being here the ſecond almicantare, and his declination for Timocharis time being $1\frac{2}{5}$ parallel northwards, do croſſe the azimuth paſsing on the ſame croſsing to the eclipticke, doth ſhew the 22. deg. of ♍, the longitude of Spica for Timocharis time. In like manner working, you may finde his longitude for Ptolomeus time, to be in the $26\frac{1}{3}$ degrees of ♍.

VVhereby alſo Ptolomeus did gather that the fixed ſtarres did go forwards one deg. in an hundred yeares according to the ſequele of the ſignes, becauſe betweene him and Timocharis paſſed 432. yeares. But nowe ſinſe Ptolomeus obſeruations, the fixed ſtars haue gone forwards 21. deg. almoſt, for now Spica is in the 17. of ♎ 36. minutes. Therefore to one degree there cannot alwayes be giuen an 100. yeare: ſince there are but 1406. yeares paſſed, but making eſtimation according to this rate, the ſtarres ſhould bee mooued one deg. in 67. yeares, yet we muſt account of ancient writers, as we would haue ours accounted of, and confeſſe that there is a certaine *Anomalion* or inequallitie of motion in the fixed ſtarres, which no man hath hither vnto better coequated then Copernicus.

Chapter 19.

The difference of aſcenſion of any part of the zodiacke or fixed ſtarre propoſed, or the oblique aſcenſion to know what the latitude of the countrie is.

Gemma Friſius 22.

NUmber the difference of aſcenſion in the parallel of the place, point, or ſtarre, propoſed from the axtree line leftwards, for north parts or ſtarres: and rightwards for ſouth, thereto ſet the *Finitor* which ſhall ſhew in the *Limbe* the poles eleuation, but if the oblique aſcention be propoſed, get the difference by the 15. vz. ſubducting the oblique aſcenſion out of the right aſcenſion, if the part or ſtarre be north: but if

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it be ſouth, then ſubduct the right aſcenſion out of the oblique, ſo haue you the difference, and then worke as before.

Example. I would know in what region the beginning of ♋ doth riſe with 60. degrees of the equinoctiall In a right ſphere it riſeth with 90. degrees. Now becauſe it is a north ſigne, I ſubtract the oblique aſcenſion out of the right aſcenſion vz. 60. out of 90. there reſteth 30. degrees, the difference of aſcenſion: then in the parallel drawne by 0. deg. of ♋ which is the verie tropicke, I number 30. deg. reckoned by the houre lines from the axtree line towards ♈, and thereto lay the *Finitor*, it ſheweth in the *Limbe* the 49. latitude almoſt: By this Chapter, the diſtinction of the Geographicall parallels, and climates are performed very eaſily.

This Chapter is alſo performed eaſily by the *Reete*, numbring in the *Limbe* the difference of aſcenſions from 6. of the clocke downewards for north ſignes and ſtarres: and vpwards for ſouth, and thereto ſet the rule, then vnder the fiduciall line of the rule, ſet the deg. or ſtarre propoſed, and marke which horizon it toucheth, ſo haue you your deſire.

Chapter 20.

To finde the amplitude of the riſing and ſetting of the ſunne or ſtarres.

Gemma Friſius 23.

ALl men know that euery horizon hath foure principall points, videl. eaſt, weſt, north, and ſouth. There is neither the ſunne, nor any ſtarre that riſeth full eaſt, except he be in the equinoctiall where the ſunne is neuer, but being in the beginning of ♈ & ♎, at al other times he is either north or ſouth & riſeth north-eaſt or northweſt accordingly as in the 2. Booke 23. Chapt. is ſhewed. Theſe points in the ſunne riſing differ euerie day, and are called *Amplitudo ortus*, and thus are had.

Place the *Finitor* to the latitude, and follow the ſtarre or ſunnes parallel vnto the *Finitor*, the deg. betweene that point and the centre is the amplitude.

Example. The ſun being 0. deg in ♋, follow the tropicke parallel vnto the *Finitor*, placed to the 51 $\frac{2}{3}$ latitude it cutteth on the *Finitor* 40. degrees reckoned from the centre which is the ſunnes amplitude of riſing.

To do the ſame another way on the Horizons.

Blagraue. Place 0. deg. of ♋ on the northeaſt part of the 51 $\frac{2}{3}$ Horizon, and marke what parallel of the *mater* reckoned from the pole, doth cutte the ſame horizon in the ſame point, and you ſhall finde the 40. parallel agreeable to the former operation. This coulde neuer bee performed in this manner by any other Aſtrolabe: the reaſon heereof is for that the north pole of the *mater* repreſenting the eaſt point, by the ſeconde booke 23. Chapter, all the horizons are by the parallels artificially deuided into 360. degrees. You may alſo get the amplitude of the ſunne by obſeruation, thus: place the *Iewel* flatte with the Horizon, ſo that the nooncline may lie iuſt in the meridian fixed, then when the ſunne is riſing turne about the ruler, till you may ſee him throw the ſightes, and reckon the degrees which the rule cutteth on the *Limbe*, from the noone line, which if they happen to be 90. then is there no amplitude, for the ſunne riſeth full eaſt, but if it be more or leſſe then 90. ſubduct the leſſe from the greater, the remaine is your deſire.

Example. The ſunne being 0. in ♋ at the riſing, the rule ſhall cutte 130. deg. reckoned from the noone-line, therefore taking 90. thereout it leaueth 40. the amplitude in our latitude.

Chapter 21.

The amplitude of the riſing of any knowne ſtarre giuen, or of the ſunne, with his place in the Zodiacke to know the latitude of the countrie agreeable.

Gemma Friſius. 24.

ADmit the amplitude of the ſunnes riſing being 0. degrees in ♋ were giuen to be 50. degres, to know in what latitude that happeneth, reckon 50. deg. on the *Finitor* from the center, and applie the ſame to and fro till it cutte the ſunnes parallel, which then is the tropicke, and you ſhall ſee in the *Limbe* the pole eleuated 58 $\frac{2}{3}$ degrees almoſt, the latitude ſought for, and ſo may you do with the amplitude of any ſtarre and his parallel.

To finde the ſame by the Horizons.

Blagraue. Reckon the amplitude of the ſunne or ſtarre from the pole among the parallels, and to that parallel lay the deg. of the ſunne or the ſtarres Apex, and the horizon paſſing there ſheweth the latitude. This likewiſe could not be done by any other Aſtrolabe before this.

Example. Admit I had taken the amplitude of the great ſtarre *Oculus tauri*, as before in the addition of the laſt Chapt. or elſe that it were otherwiſe propoſed to be 45. degrees, I reckon from the North pole the 45. parallel, and turne about the *Reete* till the ſtarres Apex do touch the ſame, and there preſently doe I ſee the 67 $\frac{1}{6}$ Horizon, wherby I conclude that where the amplitude of *Oculus tauri* is 45. the latitude of that countrie is 67 $\frac{1}{6}$ deg.

Chapter 22.

To know the riſing and ſetting of the ſunne, and the ſemidiurnall arch of the ſunne and ſtarres.

Gemma Friſius 25.

PLace the *Finitor* to the latitude, and then marke where the ſunnes parallel doth cut him, the houreline lighting there ſheweth your deſire.

Example. The ſunne being in the 10. degree of ♉, I woulde knowe his houre and time of riſing and ſetting, his parallel of declination by the 4. is 15. northwards, therefore I follow the 15. parallel to the *Finitor*, and the houreline cutting him there, doth ſhew me 5. degrees before fiue of the clocke, the ſunne riſing, that is 40 minutes, or $\frac{2}{3}$ of an houre after 4. and by the afternoone figures the ſame houreline ſheweth 5. deg. after ſeuen of the clocke the ſunne ſetting, that is 20. minutes, or $\frac{1}{3}$ of an houre after 7. for euerie deg. of the equinoctiall is 4. minutes of an houre.

Now for the ſemidiurnal arch the portion of the ſonnes parallel betweene the *Finitor* and the *Limbe*. or meridian ſheweth it videl. an 100. deg. or 7. houres and 5. deg. then reckon backe againe from the *Limbe* to the *Finitor*, or double it, & ſo haue you the whole dyurnal arch vz. 200. deg. or 14. houres 10. degrees, which taken out of the whole circle, which is 360. deg, or 24. houres, it leaueth 160. deg. or 9. houres, and 5. deg. the length of the night.

The ſame may be done eaſilie by the *Reete*, place the deg. of the ſun on the eaſt part of the horizon of your countrie, as in the ſecond Booke 23. Chapter, and thereon alſo lay the rule, and it ſheweth in the *Limbe* the houre of the ſunne riſing, from which houre, number the degrees vnto the nooneline, ſo haue you the ſemidiurnall arch.

But for ſtarres it is beſt to be done the firſt way bicauſe the ſtarres parallel in all reſpectes performeth it as the ſonnes parallel did.

Example. The *Finitor* being ſet to our latitude vz. 51 $\frac{2}{3}$, I follow the parallel of *Oculus tauri*, which either by the 7. or 17. I find to be the 15 $\frac{50}{60}$ parallel vnto the *Finitor*, and there do I ſee to be betweene the *Limbe* and it 111. degrees, or 7. houres, 6. degrees, his ſemidiurnall arch, which doubled, maketh 222. deg. or 14. houres and 12. deg. his diurnal arch, which is as much to ſay, as ſo many houres and deg. the ſame ſtarre doth remaine aboue the horizon in our countrie, and the ſaid 222. degree, or 14. houres, 12. deg. ſubducted out of the circle, leaueth his nocturnall arch, 138. deg. or 9. houres 3. degrees.

Heere note that the difference of aſcenſion of the ſunne, or any ſtarre learned by the 13. added to 90. maketh the ſemidiurnall arch, for North ſignes and ſtarres. but for ſouth it muſt be taken out of 90.

Alſo the houres of ſunne riſing, and ſetting added, alwayes make 12. alſo if you double the houre of ſunne ſet, thereof commeth the length of the day, that taken from 24. leaueth the length of the night, as if the ſunne ſet at 7. of clocke, double that, it maketh 14. houres the length of the day, the reſt of 24. is the night.

Chapter 23.

The quantitie of the longeſt day of any countrie propoſed, how to get the eleuation of the pole there, and of the diſtinction of the climates and parallels.

Gemma Friſius 26.

IT is ſaide that at Conſtantinople the longeſt day is 15. houres, 12. minutes, the queſtion is, what the latitude is, there deuide the day in halfe, there commeth 7. houres 36. min. or 9. deg. for euery 4. min. are one degree, the houre of Sun ſet. Now therfore apply the *Finitor* to the place in the Sommer tropicke, where it cutteth the 7. a clocke houre line, and 9. degrees paſt, and ſo ſhal it ſhew in the *Limbe* 43. deg. the height of the pole at Conſtantinople.

To doe the ſame by the Reete *and Horizons.*

Blagraue. Lay the rule vnto 7. a clocke and 9. deg. paſt at night, in the *Limbe*. and thereto lay the beginning of ♋ which ſhal cut among the horizons the 43. as before, which is the latitude ſought for.

Alſo if an ignoraunt man were in a ſtrange countrey, and did bring home what houre the Sun did ſette any day in the yeere, you might therby know the latitude thus. Admit he were at Conſtantinople the 20. day of May, and that then eyther by dyalles or clockes, he perceiued the Sun to ſet at 7. a clock and halfe an houre paſt, and that thereby I would know the latitude there: I lay the ruler on 7. a clocke and 7. deg. paſt on the VVeſt part in the *Limbe*. thereto doe I lay the degree of the Sun for that day, which I finde by the theoricke, as in the 3. chap. or otherwiſe by tables to be 9. in ♊, and there preſently doth the ſame 9. deg. of ♊ chooſe out the Horizon for Conſtantinople, as before: vz. 43. which is the latitude ſought, but when the Sunne is neere the Eqninoctiall points, vz. 0. in ♈, or ♎, it can hardly be done, by reaſon the horizons be there neere together. You may performe the ſame the former way, by reckoning the 7. houres, 7. deg. on the Sunnes parallel being the 22. & therto lay the *Finitor*, it ſheweth the latitude. Note that the farther off the ☉ is from 0. in ♈ or ♎, the more exact.

Gemma Friſius.

Climates. Parallels.

The climates are parallel circles on the earth correſpondent to the parallel of the ſphere, in whiche the longeſt day of the yeere is increaſed or ſhortned halfe an houre. The Geographical parallels are the like circles, encreaſing the longeſt day a quarter of an houre. The Climates begin from the fourth of theſe parallels, of which the Equinoctial is the firſt, ſo that the middeſt of the firſt climate hath his longeſt day, 13. houres which middeſt the 5. of theſe parallels doth determine. Looke hereof in my 1. Booke, chap. 10.

Therefore by the quantitye of the longeſt daye, you maye knowe vnder what parallell or clymate any countrey is ſcituate in this manner. Out of the number of the houres of the longeſt day, take 12. the remainder, reduce to quarters of houres, to which adding one the number and order of the parallel deſired, is knowen.

As in example, here at Reading the longeſt day is 16. houres, and a quarter of an houre long, & ſomwhat better,

better, I woulde knowe in what paralel we dwell, I take 12. houres out of the same $16\frac{1}{4}$ houres, there resteth 4. houres $\frac{1}{4}$, which maketh 17. quarters of houres, to them I adde one, it maketh them 18. I say therefore that we dwel in, or vnder the 18. parallel. And now hauing found the number of the parallel, take out of it 3. & ½ halfe the remainder sheweth the order of the climate, as in example before, take 3. from 18. there resteth 15. the halfe, thereof being 7. and a halfe, sheweth the middle of the seuenth climate and a halfe past that is to say, we dwell in or vnder the very beginning of the 8. climate.

But if any man would proceede beyond the pole circle, to know the latitude where the longest day is two monethes, or 60. dayes, take halfe that number videl. 30. and in the ecliptick line, reckon to many vz. 30. from ♋ towards the centre, it endeth at 0. in ♌: I reckon then the distance of the parallel passing thereby from the pole, and finde it 69. deg. $\frac{4}{5}$ which I say is the latitude where the day is 60. dayes long.

By this Chapter any man may make tables of the parallels, and climes, and if he list, note them in the *Limb* of the *Iewel*, and may see the diuersitie of them for Ptolomeus time, when as the sunnes greatest declination was almost 24. deg. which now is scant $23\frac{1}{2}$ degrees. Note also that some haue begun the clymats from the equinoctiall, and some otherwise, &c.

Chapter 24.

To know what houre of the day or night the Moone, or any planet or starre riseth or setteth on the horizon.

Gemma Frisius 27.

TO performe this proposition you must haue the day giuen with the deg. of the sunne, the latitude: and whither he be a North or South starre, then proceede thus: lay the apex of the starre vpon the northeast quarter of the horizon proposed, if it be a North starre, or on the Southeast quarter, if it be a South starre, then the rule laide to the degree of the sunne, sheweth in the *Limbe* the houre required.

Example. The first day of Ianuarie 1580. the sunne being by the 3. Chapter in the 21. of ♒, I assaide to know what time the great starre called *Canis maior*, the great dogge did rise on our horizon at Reading. Now because he is a south declining starre, I laid his apex on the Southeast quarter of the $51\frac{2}{3}$ horizon, and then turning the rule to the 21. of ♒, it shewed me in the *Limbe* 6. of the clocke and 5. degrees past and better: whereby I concluded that in our horizon or latitude at Reading, *Canis maior* did rise the said first of Ianuarie 5. degrees, or 20. minutes and better after sixe of the clocke at night. Likewise for his setting the same day (or rather night I might say) I laide the starres apex on the Southwest part of the same horizon, and the *Label* to the saide degree of the sun, it sheweth in the *Limbe* 3. of the clocke and 8. degrees past, that is 32. minutes after 3. of the clocke in the morning, at which time *Canis maior* did set againe vnder our horizon that day.

But if you would know the rising and setting of any starre that is not made or placed in the *Reete*, then by the 21. get his semidiurnall arch, and reckon the same on the *Limbe* from the noonepoint Eastwards, and thereto lay the rule, then turning about the *Reete*, place euen with the rule the deg. of mediation, or culmination of the star, that is, the deg. of the ecliptick, rising with the same starre in a right horizon by the 11. Chapter: that done, turne the rule without mouing the *Reete* vnto the degree of the sunne, & it shall shew as before, the houre sought for.

Admit for example that *Canis maior* were not in my *Reete*, therefore I gette his semidiurnall arch, which by the 21. Chapt. I finde to be in 68. deg. $\frac{1}{4}$ or 4. houres, and $8\frac{3}{4}$ degrees all is one, which being reckoned on the *Limbe* from noone Eastwards, I lay thereto the rule, then by the 11. finding that the degree of culmination of *Canis maior* is the $6\frac{1}{2}$ deg. of ♋, I lay the same euen with the rule, and there the *Reete* resting, I turne the rule to the degree of the sunne, as before vz. 21. of ♒, there I finde in the *Limbe* 5. degrees after 6. of the clocke, as before, the rising of *Canis maior*: and for his setting I reckon $68\frac{1}{4}$ deg. from noone westwards, and thereto lay his culmination vz. $6\frac{1}{2}$ of ♋, and thence turning the rule to the 21. of ♒ it sheweth there in the *Limbe* 8. deg. past 3. in the morning, his setting, as before. Remember alwayes in your working of starres that *Locus solis ostendit horam.*

Likewise for the Moone or any planet hauing no latitude from the ecliptick, which seldome happeneth but they haue laide the deg. of the zodiacke on the horizon, as you did the starres apex, and then *Locus solis ostendit horam*: Looke more in the 33. Chapt. of the 2. Booke.

Blagraue. You shal vnderstand, if the moone or any planet be much in latitude, as they cannot be aboue 6. deg. and the moone not aboue 5. at the most, that then there may happen a great diuersitie of their rising and setting, if you should but onely lay their deg. of the zodiacke to the horizon as before, which the expert practiser for all the planets will easily remedie: but for the moone you haue more to do, for if you take her deg. out of the ephemeris, or the common Almanacks, the same is but her degree at noone for that day, for at 6. of the clocke at night, she wilbe 3. degrees farther in the zodiacke: the cause is, she walketh the whole zodiacke in a moneth, and euery 2. houres after a sort one deg. and somwhat more: wherefore you must adde for euery two houres past noone, one deg. & before noone subduct, and yet commonly in tables the day endeth at noone, & this day beginneth yesterday at noone.

Chapter 25.

To know what starres neuer rise or set to euery region, and which are verticall.

Gemma Frisius. 28.

FOr these take these general preceps, that star whose declination is equal to the latit. so that the declination & latit. be both north, or both south, doth still once in 24. houres come to the zen. as appeareth by the zen. point of the *Iewel*, which toucheth in our latit. the $51\frac{2}{3}$ parallel: also those stars whose declination southwards is equal to, or greater thē the equinoct. height, are neuer seene in that country, as for example set the *finitor* to our

latitude 51 2/3 you shall see on the *Iewel* that the 38 1/3 parallel southwards doth but touch the *Finitor*, the rest beyond him neuer are seene: contrariwise those North starres whose declination exceedeth the equinoctials height, do neuer set, as by the *Iewel* may apparantly be seene. Farther if you would know to what countrie any starre or signe is verticall, seeke his declination, and where his parallel lighteth on the *Limbe*, thereto set the zenith point, and so the *Finitor* sheweth the latitude.

Chapter 26.

Of the Cosmicall Eliacall and Acronicall rising and setting of the starres.

Gemma Frisius 29.

THe Cosmicall rising is when as the starre riseth on the horizon with the sunne neare one instant, and is had if you place the starres apex on the East part of the horizon, the deg. of the zodiacke cutting then the horizon, is your desire, then by the theoricke you may finde the day of the yeare answering thereto. But if the starre desired be not in the *Reete*, then reckon his semidiurnall arch, from noone Eastwards, and thereto lay his degree of culmination, had by the 11. and marke what deg. of the zodiacke, doth cut the horizon on the East part, the same is also your desire.

The Cosmical setting, is when any starre doth set at one instant when the sunne riseth, or neare it, which is as easily had as the other by laying the starres apex on the VVest part of the horizon, and then the deg. of the zodiacke rising on the east is your desire: if the starre be not in the *Reete* reckon his semidiurnal arch Westwards, and lay thereto his culmination, and so againe the ascendent is your desire, euen as before.

The Acronicall rising is when a starre riseth the sunne setting, place the starres apex on the east part of the horizon, and then marke the deg. of the zodiacke, descending on the VVest, for when the sunne comme th thither, then doth that starre rise *Acronicè*, and this may you do by his semidiurnall arch also as before.

The Acronicall setting, is when a star setteth with the sunne, and is easie to be vnderstood by the premises.

The *Heliacall* rising of a starre, is when he getteth out of the sunne beames, and the *Heliacall* setting, is when he getteth into the sunne beames: but heere you must note that the greater starres may be seene when they are more neare the sunne then the lesser. Starres of the first light are not seene except they be 12. degrees distant from the sunne, of the second light 13. of the third 14. of the fourth 15. of the fifte 16. of the sixt 17. Then for the planets, Saturne requireth distance 11. degree ♄ 10. ♂ 11 1/3 ♀ 5. ☿ 10. but these be not alwayes certaine, for the planets turning in their epicicles, doe now shew greater, and now lesse, also the inclination of the zodiacke to the horizon may somwhat alter them, and the state of the aire also.

Chapter 27.

How to know what it is a clocke in the night time by the starres.

Gemma Frisius 31.

THe sunne onely sheweth the houre at all times, yet by the starres or planets in his absence we doe finde him out, and so get the houre.

Take the height of the starre, and marke whither he be East or VVest from the meridian (for always the farther from the meridian the starre is, the surer you worke) then set the *Finitor* to the latitude, and reckon the starres height so taken among the almicantares, & where that almicant. and the starres parallel do crosse the houreline cutting there, sheweth the houre distance of the starre from the south, which is called *Hora stella*, the starres houre: but now by this to get the true houre, reckon this houre distance of the starre on the *Limbe* Eastwards, if the starre were on the east side, or westwards, if on the VVest: and thereto lay the starres apex by helpe of the rule, or his degree of Culmination, if the starre be not in the *Reete*, and the *Reete* there standing turne the rule to the deg. of the sunne, it sheweth the houre sought for on the *Limbe*. This asketh much businesse by Gemma Frisius Cursor and Brachiolum.

Example. The 6. of October 1580. I went forth and tooke the altitude of a faire great starre called Hircus the Goate 20. deg. being then northeast, whose declination is 45. degrees North, then placing the *Finitor* to the latitude I marked where the 20. almicantare cut the 45. parallel, the houreline crossing them there in their point of meetings shewed foure houres & 2. degrees, the houre distance of Hircus from the north part of the meridian Eastwards: and that which more is then Gemma Frisius Astrolabe could shewe at one instant, the azimuth crossing there also with them, sheweth in what verticall circle the starre was, but to the matter: Because the starre Hircus was on the east side of the North part of the meridian; therefore in the Northeast quarter, I reckoned on the *Limbe* from North *Media nox* Eastwards, the starres houre vz. 4. houres 2. deg. and thereto by helpe of the rule I laide the starres Apex, the *Reete* there standing, I turned the rule to the degree of the sunne which then was in the 23 1/3 deg. of ♎, and found it pointing on the *Limbe* 7. of the clocke, and halfe an houre past within little the houre sought for.

Gemma Frisius 32. Heere Gemma Frisius maketh a Chapter to reckon the houres from noone vnto 24. ending the next day at noone, as the Astronomers doe, and likewise from sunne rising or sunne set to 24. as diuerse nations do, but seeing it so easie and friuolous for our countrie I omit it: I shall adde much and therefore had needs be short in some.

Chapter 28.

Of the vnequall or planetarie houres.

Gemma Frisius 33.

EVerie artificiall day is accounted betweene sunne rising and sunne set: the night accordingly from sunne set to the rising, the 12. part of euerie such day is called a planetarie houre, so that as the dayes are longer and shorter, so are the houres, and therefore called vnequall. They are called planetary because auncient Astrono-

Aſtronomers haue held opinion that the ſeuen planets in order haue dominion, theſe houres giuing that planette to the firſt houre of the day, after which hee is called as on ſunday ☉ hath the firſt houre the next ♀ then ☿ ☽ ♄ ♃ ♂, which endeth in the 7. houre, and then beginne agayne the 8. houre with ☉, and then forwards ♀ ☿, &c. as before with the 12. night houres alſo, and you ſhal finde that ☽ will hitte righte to begin the 1. houre of the day following, whereof the day hath his name, which is the cauſe that the week dayes are not named according to the order of the planets.

Blagrane. Gemma Friſius appoynteth a particuler quadrant on the backe of the Aſtrolabe for the planetary houres, eyther the ſame, or very like it which Stophler appointed, but I like not to haue any thing particular to one latitude, in ſo general a *Iewell*. I would rather doe thus: deuide the ſemidiurnall arch by 6. and by the quotient, deuyde the arche of the houre ſought from Sun riſing: as for example, the Sun being in the beginning of ♋ the ſemidiurnal arch is 124. deuide that by 6. the quotiēt is 20. $\frac{4}{6}$ deg. admit at 10. a clocke before noone, I would know the planetary houre, the arch thereof to the *Finitor* is 94. deuide that by 20. & let the $\frac{4}{6}$ alone, thence commeth 4 $\frac{14}{20}$ that is to ſay, the 4. planetary houre, and $\frac{14}{20}$ paſt, that is as good as $\frac{2}{3}$ partes.

But for thoſe that canne no Arithmeticke, an eaſier waye is thus, and for that cauſe chieflye did I diſtinguiſh all my meridians by ſixes, with great ſtrokes: beginne from the *Finitor* with the next ſixt meridian that cutteth the paralel of the ſun, and thence tell euery 6. on the ſame parallel with a ſticke as they ſay, vnto the *Limbe*, and count how many they be, and looke how many ſixes you haue on that parallel, ſo manye degrees reckon to euery planetary houre on the ſame parallel, as before in the laſt example: you ſhall finde 20. ſixes, and foure degrees ouer: reſpect not thoſe 4. but go on with 20. for the firſt planetary houre from the *Finitor*, and 20. for the next; and ſo on till you come to the 10. houre deſired, and if you will work exquiſitely for euery planetary houre reckoned, account 4. and then ſee how oft you can take out 6. & ſo many degrees, adde to the end of your reckoning, and ſo haue you the planetary houre exactly, as in example before, at 10. of the clocke, it was found the fourth planetary houre, almoſt the 5. therfore I heape 4. together 5. times, it maketh 20. thence, I can take 6. 3. times: which 3. I adde to the planetary houre before found; ſo that now it is the 4 $\frac{17}{20}$ houre, that is almoſt the fift.

Alſo the *Finitor* being ſet to the latitude, he that would deuide the 3. arches of the Equinoctiall, and the two tropicks, into ſixe equall partes betweene the *Finitor* and the *Limbe*, and ſo draw arches from tropicke to tropicke, by helpe of eche of theſe 3 pricks, might ſo haue the planetary houres for that latitude, but this being particuler, is not conuenient in the *Iewell*. But if any man did deuide euery 3. parallel betweene the tropicks in 6. parts, and did but only ſet great perceiueable pricks at euery part, it woulde ſerue and not muche hurt. This matter is not weighty, and therefore let euery man doe his pleaſure.

Chapter 29.

How by the Iewell *to know the Meridian or greateſt altitude of the ſunne and ſtarres.*

Gemma Friſius. 34.

THe innermoſt circle of the *Limbe* in reſpect of the *Mater*, repreſenteth alwayes the Meridian in euery latitude: wherefore the *Finitor* being ſet to the latitude, marke where the parallel of the Sunne or any ſtarre doth touch the *Limbe*, the almicantare touching there with him, ſheweth ſtreight the Meridian altitude.

The ſame another way.

Blagrane. Lay the degrees of the Sunne or ſtarres apex to the noone line, and if he bee a South ſigne or ſtarre, you neede but reckon on the noone line, the diſtaunce from your horizon vnto him, the ſame is your deſire. As for example, the 7. of ♎ layde to the noone line, ſeeke out the 51 $\frac{2}{3}$ horizon, chap. 29. and you ſhal finde the diſtaunce betweene it and the 7. of ♎, reckoning on the noone line 29 $\frac{1}{3}$ degrees. But if it bee a North ſigne or ſtarre then laid to the noone lyne, you muſt reckon from the horizon to the *Limbe*, and thence backe agayne towards the horizons, till you come to the degree or ſtarre, as if you would know the meridian height of the 7. of ♈ or ♍, lay either of them to the noone line, then from the horizon to the *Limbe* in our latitude is alwayes 38 $\frac{1}{3}$ degrees, and thence reckoning backe, you ſhall finde 3. degrees, which added makes 41 $\frac{1}{3}$ degrees, the altitude ſought, and ſo for ſtarres.

Chapter 30.

How to finde the degree of Medium Cœli, *or Culmination called middeheauen at any time propoſed.*

Gradus medij cœli
Culmen cœli
Cor cœli.

Gemma Friſius. 35.

THe degree of the Zodiacke being in the Meridian at any inſtant, is called in Latine the *Gradus medii Cœli*, of ſome *Culmen Cœli*, and *Cor Cœli*, that is the top and heart of the heauen.

By helpe of the *Reete*, it is eaſilye had, laye the degree of the Sunne in the Zodiacke vnto the houre and time propoſed, by helpe of the rule, and then looke what degree cutteth the noone lyne, the ſame is your deſire.

Example, the Sun being 6. degrees in ♌, I would know the degrees of the mydheauen or Culmination, at 8. a clocke in the forenoone, I ſet the 6. of ♌ vnto 8. a clocke by the rule, and then in the noone line towards the handle, I ſee there 9 $\frac{1}{2}$ deg. of ♊ the deg. ſought for, and in the ſame noone line vnderneath I ſee the 9 $\frac{1}{2}$ of ♐, which is called *Gradus Imi Cœli*, the deg. of deepe heauen or the Angle of the earth.

To

To doe the same by the *Mater* without the *reete*, first to get the right ascention of the degree of the sunne, and then his distance from the South in degrees and minutes, take this distaunce for forenoone howres out of the right ascension of the Sunne, if it may not be, adde 360. to the ascenfion, & then subduct it, but for afternoone howres, adde the distance to the ascenfion, & if the whole summe exceede 360. cast away 360. so haue you the right ascention of the culmination, then the degree of the Zodiacke answering, is had by the 10.

Example. the Sun being in the 6. of ♌ as before his right ascention is $128\frac{1}{3}$. & because the howre before is of the forenoone distance from the meridian 4. houres or 60. degrees. I subduct 60. out of $128\frac{1}{3}$. there resteth $68\frac{1}{3}$. degrees, the right ascenfion of the degrees of culmination: then by the 10. Chap. I finde the degree of the Zodiacke, answering thereto, to be $9\frac{1}{2}$. degree in ♊ as before.

Chapter 31.

To know how much any degree or point of the heauen is distant from the Meridian at any time by degrees of the Equinoctiall.

Gemma Frisius. 36.

LAY the degree of the Sunne vnto the houre proposed on the *limbe* by helpe of the rule, and then turning the rule about to any degree, starre or other point in the *reete*, it sheweth in the *limbe* the distance thereof from the meridian, either in degrees or houres. This propofion is necessary for directions, and needeth no example. Note that for starres not in the *reete*, their deg. of culmination serueth the rule applyed thereto.

Chapter 32.

How by the Iewell to know the height of the Sun aboue the horrizon euery houre and time of the yeere sitting within dores: and thereby to make tables to any latitude, for making of particuler Dials, as Cylinders, ringes, quadrants, & such like.

Gemma. 37.

Gemma Frisius heere commendeth the profite of this Chapter, specially for making tables for particuler dials, saying that it hath a wonderfull facilitie of working by his Astrolabe, but truly by my Iewel the working is an hundred fold more easie: For my *finitor* being once placed to ♑ latitude, he that vnderstãdeth the 6. chap. the 21. & 26. may see his table as readie made vpon his *Iewel* as *G. Frisius*, or any man els can make him the other way with 3. or 4. houres paines: and that which more is, you neede but the *finitor* vnto any other latitude, and so is your *Iewel* a table readie made also to the same, so that you may heereby peruse tables for many latitudes in lesse time then you could peruse for one latitude after *G. Frisius* by his cursor and Brachiolum.

Example. the 13. of September 1588. the Sun then in the 0. degree of ♎ I woulde know of what height the Sun is euery hou re that day, I place the *finitor* to the latitude vid. $51.\frac{2}{3}$. here at Reading, then do I marke what Almicantares do cut the Sunnes paralell being here the equinoctial, in the crossing of euery houre line: I see at the *limbe* being 12. of the clock the $38\frac{1}{3}$. degrees or Almicantare: at 11. whiche also serueth for 1. in the afternoone 37. almost, at 10. & 2. $32\frac{1}{2}$. at 9. & 3. 26. at 8. & 4. 18. & better, at 7. & 5. 9. & at 6. & 6. 0. because the Sun then setteth, & is nought aboue the horison. This doth *G. Frisius* aduise to set in a table. doing the like with euery paralel, or euery 3. paralel at the least, of the Sunnes declination, & when you haue done, your table shalbe no readier then my *Iewel*: for the paralel of declination knowne, I can goe vpon hym from houre line to houre line, either for quarter, half houre, or other minute, & there see presently what Almicantare doth limit the height, which your table cannot do, except you make him almost infinit to euerie minute, for which purpose only my *Iewel* were worthie to be accounted of.

Chapter 33.

How to know the height of any starre aboue the horizon sitting close within dores, and thereby to learne to know the starres in the skie.

Gemma Frisius 38.

THis chapter bringeth any man to the knowledge of euerie seuerall star & their names, and for other vses is commodious: if the star be in the *reete* whose altitude yee seek, then lay the degree of the Sun to the houre, & part at which you desire, the height by help of the rule, & then turne about the rule to the starres Apex, which sheweth in the *limbe*, the starres houre, or distance from the South, by the 30. and if you reckon on the rule the degrees, from the starres Apex to the *limbe*: you haue the starres declination also, and whether his declination be North or South I shewed in the 2. booke 21. chap. This done, set the *finitor* to the latitude, & then on the starres paralel reckon from the *limbe* his houre distance, before found, & mark what almicantare doth crosse there, the same sheweth the starres height for that instante, & the Azimuth also cutting there, sheweth the verticall circle, in which the star is, which is more then was proposed.

But if the starre be not in the *reete*, then must you get his declination by tables, & likewise his culmination and vse his degree of culmination in steed of the starres Apex, as in the 24. 25. 26. &c. and then proceede as before in all respectes.

Blagraue Here *G. Frisius* setteth no example, but truly I think it good, because this chapter brought mee too knowe the starres as well in the skie as I did on my *reete*. The fifteenth of October 1576. about eyght of the

of the clocke at night, whileſt I was reading of Copernicus reuolutions, and Stadius, conferring them together, I found there that the auncient Aſtronomers appointed the firſt deg. of the Equinoctiall to begin from a ſtarre of the ſecond light, neere the Eclipticke called *Cornu arietis*, whoſe longitude was in olde time in the very vernal interſection of the eclipticke with the Equinoctiall, which ſtarre by reaſon of the motion of the ſtarres *Apogea*, or more plainly of 8. and 9. ſpeeres called *Motus preceſſionis Equinoctiorum*, is gone forwards 27. deg. 40. min. ſo that now he is in the 27. deg. 40. min. of ♈. For this cauſe I was deſirous to know that ſtarre in the ſky as well as on my *Reete*. The Sunne then being in the $27\frac{1}{6}$ deg. of ♎, I layde that deg. to 8. a clocke in the *Limbe*, thence turning the rule to the ſtarres apex, I found in the *Limbe*, the ſtarres houre diſtance from the South 3. houres and 13. degrees, almoſt towards the Eaſt, & on the rule his declination $17\frac{1}{2}$ deg. VVherefore I ſet the *Finitor* to the latitude, and on the $17\frac{1}{2}$ parallel Northwards, I reckoned 3. houres and 13. deg. inward by the houre lines, and I found there croſſing the $33\frac{1}{2}$ almicantare the heighte of the ſtarre: & there preſently I ſaw likewiſe the 15. azimuth reckoned from the Eaſt or zenith line, to cut the ſame place of the ſtarre. Then with ſpeede I ſet the rule with his ſights on the backſide, ready vnto ſo many deg. vz. $33\frac{1}{2}$ aboue the line of leuell, and going abroade I turned my face towards the 15. azimuth as neere as I could geſſe from the Eaſt Southwards, and there might I ſee the ſtarre ſought for through the ſight holes, and ſo by noting his place and the ſtarres about him. I knew him euer ſince.

Gemma Friſius 39. To fynde in what verticall circle or azimuth the Sunne, or any planet or ſtarre is, anye time.

Blagraue. Here Gemma Friſius maketh a ſpecial chap. for that which my *Iewell* yeeldeth vnasked, as by the 6. 31. 38. and diuers other chap. appeareth. Note that before the lodeſtone, found, men ſayled by the verticall circles of the Sun and the ſtarres.

Chapter 34.

How to finde the Meridian line, and the foure quarters of the worlde called cardines, *diuers wayes, and ſpecially by the Aſtrolabe.*

Gemma Friſius. 40.

BY the Sun you may doe it any houre. firſt getting the azimuth by the 6. and then lay the rule to the lyke degree Eaſtwards, or VVeſtwards on the *Limbe*, as the Sunne ſhal then be, and the rule there fixed, lay the *Iewell* flat on a ſtoole, or by ſome deuiſe leuell with the horizon, and turne him about till the Sunne ſhine through both the ſight holes, and then will the noone line of the *Iewell*, lye euen in the Meridian, by which you may draw your line, but here had you neede of a wyre ſet vp plumme in the furthermoſt ſight hole, and ſo lette his ſhade couer the other, becauſe the Sunne beyng aloft cannot pearce the ſightes, as in the ſeuenth is ſaid.

Another way. Erect a ſtile or wyre plum on any horizontall plaine in the forenoone, and hang the *Iewell* that the Sunne pearce the ſight holes, and marke both what deg. the rule cutteth in the *Limbe*, and where the ſhade of the top of the ſtyle endeth on the plaine, and there ſet a pricke, let the *Iewell* hang ſtill, till the Sun in the after noone pearce agayne the ſights, then ſet another pricke where the ſtiles ſhade endeth, then frō the ſtile draw a line iuſt betweene thoſe prickes, the ſame is the Meridian, and croſſe the ſame ſquare with another. and that ſheweth Eaſt and VVeſt.

Another way. Make a conuenient circle on a plain in the centre, ſtick a ſtile plum, marke both in the forenoone and after noone, where the ſtiles ſhade toucheth that circle, then draw a lyne from the centre to the middeſt of that arche betweene the touches, the ſame is the Meridian.

Another. The Aſtrolabe placed on an horizontall plaine, as before, and the Sunne ſhining, at Sunne ryſing, and likewiſe at Sunne ſetting through the ſight holes, the degree betweene both, ſheweth the Meridian line.

Another. Get the amplitude of the Sun by the 19. chap. number it on the *Limbe* from the noone line, and therto lay the rule and the *Iewel* leuel with the horizon, marke at Sun riſing, that the beames pearce the ſights and then is the noone line your deſire.

Blagraue, Though Gemma Friſius hath ſet downe wayes inough to find the Meridian, yet all of them depend vpon the ſhining of the Sun, and in the day time. Therefore I wil ſhew two other wayes in the night, by the ſtarrs, nothing inferior to the other. For, in like maner as you did the firſt way by the Sun, may you do by any ſtarre hauing gotten his azimuth by his houre diſtance from the South by the 26. or 32. the deg. of the azimuth, reckoned on the *Limbe*. and the rule fixed therto, laying the *Iewel* flatte, as before in the Sun, turne him til you may ſee the ſtarre, euen with the ſightes which here had neede be wyres both.

The ſecond way is that which I vſed, before I knew any other almoſt to ſet dyalles by, and in my opinion is nothing inferior to anye of thoſe before. Thus woulde I do whē I had made my horizontal dial, & ſodered on the cocke or *Gnomon*, I wold chooſe a bright ſtarry night, & then bring forth my dial, & ſet him on the poſt where he ſhould ſtand, then had I a playne ſquare little boorde, or rather then fayle, a fayre ſquare trencher, this ſquare boord would I faſten or hold perpendiculer, cloſe to the cocke, and ſo turne about cocke, dyall, boorde and all together, till I might ſee the laſt ſtarre of the tayle of *Vrſa minor*, which they commonly cal the pole ſtarre, euen with the boord, and then was I ſure the cocke ſtood North and South, and ſo would I naile my dyal on.

But in this way you muſt not neglect two things, one is that the boord ſtand plumme vp with the cocke, at the time of view. The other which truely in thoſe dayes I tooke no regard vnto, becauſe I knew it not, for I could make dyalles before I ſtudied Aſtronomy: and that is this: you muſt by helpe of your *Iewel*, chooſe your time, ſo that the beginning of ♈, or ♎, be in, or neere the meridian either aboue or vnder the earth. For when

when ☌ & ♍ are in the meridian, the pole ſtarre declineth 3. degrees from the meridian once euery night that time may be had, halfe an houres miſſe will not alter much, or els watch at any time: when the firſt ſtar of the tayle of *vrſa maior*, called *alioth*, and commonly the thill horſe of charles waine, doth ſtand directly ouer or vnder the pole ſtarre, as it were both euen with a plumme line, then be ſure the pole ſtarre is directlie North to ſtrike your true meridian by.

Chapter 35.

The meridian founde, to finde the Azimuth of the Sunne or ſtarres by ſight without the houre.

Gemma Friſius. 41.

THE noone line of the *Iewel* placed in the meridian on any horizontall playne by the 33. you may turne about the rule to the Sunne or any ſtar by helpe of wier ſights, as in the 33., and it ſheweth in the *limbe* your deſire.

Chapter *36.*

The verticall circle of the Sunne or any ſtarre, the degree of the Sunne, with their altitude aboue the horizon, giuen howe to knowe the latitude and what it is a clocke.

Gemma Friſius. 42.

TAke the Azimuth by the 34. and the altitude by the 1. reckon the ſame among your almicantares and azimuthes on your *Reete*, & mark where thoſe two croſſe one another, the turn about the *reete* til the ſame point of croſsing light on the paralel of the Sunne or Starres declination, & the houre line lighting there with them, ſheweth the houre of the Sunne or Starre. The *Finitor* likewiſe ſheweth the latitude in the 7. This chapter is ſet downe è *conuerſo* almoſt: if you vnderſtand the 6. the 26. Chapter and others, this is very eaſie.

Chapter *37.*

The latitude, the Sunnes Azimuth and almicantare giuen to finde his place in the Zodiacke.

Gemma Friſius 43.

ABout the Tropickes this rule is vncertaine, as in the 9. chapter is ſhewed, where in the end of my addition this Chapter is perfourmed.

Chapter 38.

To know what houre the Sunne or any Starre commeth to any azimuth propoſed.

Gemma Friſius, 44.

PLace the *Finitor* to the latitude, and marke what houre line cutteth the azimuthe propoſed on the Sunne or Starres parallel, the ſame is your deſire, ſauing for Starres remember, *locus ſolis oſtendit horam*, as in the 26.

Blagraue. I haue made ſhort of theſe laſt chapters without examples, becauſe my *reete* with the azimuthes and almicantares doth readily expreſſe them: but in deede by *Gemma Friſius*, working in his Curſor and Brachiolum, examples had been needfull, and ſpecially in this chapter, which by *G. Friſius* requireth great paines.

G. Friſius 45. & 46. Theſe chapters by reaſon of my new *Reete* haue no matter.

Chapter 39.

A Comet, a Planet, or an vnknowen ſtarre being ſeen in the skie, how to get his longitude and latitude in the Zodiacke, and how by the right aſcenſion and declination of any ſtarre to get his longitude and latitude.

Gemma Friſius. 47.

WHen you ſee any Comet, Planet, or Starre vnknowne: Firſt take his altitude, and the ſame Inſtant get the houre and minute by the 26. or otherwiſe very certainely, and his azimuth by the 34. Then ſet the *finitor* to the latitude, and marke what parallel cutteth the croſsing of the Comets, almicantare and azimuth, ſo found, the ſame is his parallel of declination, and the houre line cutting the ſame croſsing, ſheweth his diſtance from the meridian by the 26. This done, place the degree of the Sun to the houre in the *Limbe* before found: and then in the noone line may you ſee the degree of culminatiõ whoſe right aſcenſion ſeeke by the tenth. Nowe if the Comet bee on the Eaſt part adde to this right aſcenſion his houre diſtaunce, if on the Weſt, ſubſtract it, and ſo ſhall you gette the right aſcention of the Comet, but if in adding, the number exceede 360. caſt away 360. alſo if the houre diſtance may not be ſubducted, then add 360. and ſo the product is the Comets right aſcenſion. And nowe hauing the right aſcenſion & declination

of

of the Comet, marke where they crosse on another, and make a prick with ynke, for there is the Comets very place in the heauens then: to know his longitude and latitude, set the *finitor* to the ecliptick, and to the azimuth and almicantare cutting the pricke or Comets place before made, sheweth your desire, as in the 17. This is a notable practise and hath wonderous vse in Astronomie, and therfore worthie of an example at large.

Blagraue. VVherefore I will shew an example, whiche I my selfe for mine owne delight and experience did obserue. The nienth of October 1580 walking foorth at night, as I commonly dyd, to behold the constellations, I perceiued Southwardes a shimering or dimme light, in bigneſſe to sight, about an hand breadth, but because the skyes were cloudie, I coulde not well iudge wheather it were a Comet or some starre, with his light dissipated by the clowdes. The tenth of October, being a cleere starry night, I perceiued wel that it was a Comette, or rather, of some called a crinitall starre: it was then placed vnder the three starres of the light, called to sight about two yardes, so that it made an equicrurall triangle, with the two vttermost of those three starres. The eleuenth of October, the nyghte was cloudie and no starres seene: the twelfth of October, a cleere starrie night againe, and then I sawe the Comet was gotten aboue the saide starres about an ell to sight, and there made an equicrurall triangle, with the midlemost of the same three starres and the vtter starre VVestwardes, wherefore seeynge I was too wryte this Chapter: shortlye after seeynge the skyes so cleere, I thought good too take a little paynes for that cause.

But hauinge on that sodaine no meridian readie founde, neither my Astrolabe furnished wyth wyer sights, nor placed as in the 33. and 34. to get the Azumuth, I presently deuised by help of two long poles, set somewhat a slope, vnderteeled wyth two forkes, too hang from the toppes of eache of them a corde with a plummet pitching them too and fro, tyll at the last standing South from them a pretie way off, I might see the pole star euen with both the cordes, which deuise here serued me in steed of a meridian line, for then I went on the North side of the cordes, and watched tyll the Comet came euen with them: whiche happened presently after I was readie for him: then was I sure that he was in the meridian or South azimuth, which done, I presently tooke the height of the Comet $38\frac{1}{2}$. deg. also of the great star called Aldeburam, the bulles eye, by whiche according to the 26. I founde it eyght of the clocke the sunne then beeing in the 29. degree, 10. minutes of ♎.

Nowe because the Comets height, videlicet, $38\frac{1}{2}$. was equall in manner to the Equinoctials height, by the 7. I concluded his declination was 0. videlicet, in the Equinoctiall it selfe, and by the 29. his degree of culmination $24\frac{1}{2}$. degree of ♒, and by the 10. his right ascension 327. And then hauing his right ascension and declination, I seeke them out on the *Mater* by the 17. and marked where they crosse, and there make a pricke with ynke, for it was the Comets place at the time of my obseruation. Lastly, I turned the *finitor* to the Ecliptick, and there by the seuenteenth chapter, the azimuth cutting the pricke or place of the Comet, shewed his longitude 329. and better, whiche more plainelier is the 29. degree of ♒, and the Almicantare cutting the same pricke shewed me $12\frac{2}{3}$. degree, the latitude of the Comet Northwardes from the Ecliptick. By this chapter and the 17. a man might make a globe, with his constellations truer then some are that are solde.

Note that I sawe the same Comet or crinitall starre, about the East circle, and about 12 degrees high as neere as I coulde gesse vpon the fixe and twentie day of Nouember next following, for in truth, his proper motion was a mayne towardes the Sunne, though wandering, and then the Sunnes motion being towardes it, they had met and passed by eche other.

Chapter. 40.

Howe to knowe the quantitie of the angles which the Ecliptick maketh with the meridian at any moment.

Gemma Frisius 48.

IT hath been shewed before that the ecliptick doth alwayes diuersly or vnequally passe ouer as well a ryght horizon or the meridian of any place, as the oblique horizon, yet wyth a more diuersitie and vnlikenesse in the last, then in the first. The cause (as it hath been saide) is the deformitie of the angles or inclinations of the Ecliptick to the meridian. The determination of this chapter therefore is to teache how too knowe this inclination, which is very commodious in many respectes as shall bee shewed in their place.

First you must vnderstande that as oft as two great circles deuide, or crosse one another, they make either 4. right angles, or els 4. angles equall vnto foure right angles. Further the 2. opposite angles, at eyther point of the intersection are alwayes equal which in the Theoremes before my spericall triangle is manifested. VVherefore one of them beeynge knowen, all the reste are knowen lykewise, for doubling the angle known, & then taking that out of 360, degrees, which is the quantitie of foure right angles, there remaineth the other two angles, the halfe thereof is one of them: as too the purpose, when ♋ is in the meridian, all the foure angles are right angle when ♈ or ♎ is there, then the twoo lesser angles are alwayes equall to the complement of the Sunnes greatest declination: the other twoo, then are easily knowen as before. Know also that the degrees of the Ecliptick alike distante from eyther of the Equinoctial points, do make like angles of inclination, but in sundry partes of the heauen. In this Chapter shalbe shewed to find the two lesser angles.

First therefore by the 29. learne the degree of culmination (that is the degree of the Ecliptick) in which you desire to learne the angles that he maketh with the meridian, then marke howe farre this degree is distant from the next Equinoctiall point: the like distaunce number on the artike circle from the poynt

where it toucheth the meridian or *limbe*: for at the ende of this reckoning muſt needes bee the pole of the Zodiacke when ♈ or ♎ is in the meridian. Then applying the rule to the ſame poynt in the pole circle, it ſheweth on the *limbe* the leſſer angle ſought for, if you reckon from the Equinoctiall to the rule.

For example, I woulde knowe the quantitie of the foure angles whiche the ecliptike maketh with the meridian in the beginning of the tenth degree of ♉. The diſtance of this poynt from the next equinoctium, videlicet, from ♈ is 39. degrees, then numbryng 39. in the pole circle from the *limbe* inwards, & therto laying the rule, I finde in the *Limbe* 71. degrees $\frac{1}{3}$. the quantitie of one of the leſſer angles, whiche doubled, maketh 142$\frac{2}{3}$. this taken out of 360. leaueth 217$\frac{1}{3}$. the quantitie of both the greater angles, each of them being 108$\frac{2}{3}$. or thus 71$\frac{1}{3}$. taken out of halfe 360. videlicet, 180. leaueth 108. $\frac{2}{3}$. your deſire: Thus haue you all the foure angles.

Chapter 41.

To doe the ſame another way.

Gemma Friſius. 49.

LEarne the diſtaunce as before from the next Equinoctiall poynt, number the ſame in the rule from the center outwards, ſeek alſo the right aſcentiō of the diſtance, now learned as thogh it were diſtant frō ♈ and reckon the ſame among the parallels: then moue the rule vp and downe, vntyll ſuche time that the point of the rule before noted do light exactly on the ſaide parallell, reckoned from the Equinoctiall, and ſo doth the rule ſhewe in the *limbe*, the leſſer angle ſought for as before.

For example, I would knowe the angles which the 6$\frac{1}{3}$. of ♍ maketh with the meridian, the diſtaunce thereof from ♈ is 82$\frac{2}{3}$. the right aſcention of that diſtaunce from ♈, by the 10. chapter, is 81$\frac{2}{3}$. Therefore numbryng on the rule from the center 82$\frac{2}{3}$. and among the parallels 81$\frac{2}{3}$. I turn about the rule tyll the 82$\frac{2}{3}$. degrees thereof doe cut the 81$\frac{2}{3}$. parallell, and then doth the rule in the *Limbe* ſhew 87. deg. the quantitie of the leſſer angle.

A thirde waye is thus, gette the declination of the poinct propoſed, by the fourth Chapter, number the ſame on the rule from the *Limbe* inwardes, and laye it on the pole circle, it ſheweth on the *limbe* your deſire.

As in the firſt example, the declinatiō of the tenth degree of ♉ is 14. degrees $\frac{1}{2}$. that numbred on the rule from the *limbe* inwards, and laide on the pole circle, ſheweth 71$\frac{1}{3}$. as before, I coulde ſhew another way but it needeth not.

Chapter. 42.

How to finde the horoſcope, called the Aſcendent at anytime appointed.

Gemma Friſius 50.

THE powers of the planets and ſtarres, as they differ in reſpect of their nature, ſo are they either increaſed or decreaſed according to their cituation in the heauens. For we ſee dayly that tempeſtes are chiefly eyther raiſed or ſtayed by the Sunnes riſing, ſetting or comming to the meridian, & that the moone by commyng to thoſe foure places, doth rule the ebbyng and flowing of the Seas, and ſometimes rayſe tempeſts. Beſides that, he that wyll marke it well ſhall finde, that the riſing and ſettyng, and comming to the meridian, of the great ſtarres, and ſpecially with the Sunne, as in the 25. woorketh great effects in altering the ayre.

And therefore olde writers called theſe 4. places, the Cardines, and other newer call them angles or points, of the 4. Cardines or angles. Ptolomeus appointeth the midheauen to be chiefe and ſignifieth glory and honour: The next too bee the aſcendent, and ſignifieth life. Then the deſcendent, and ſignifieth deathe. Laſtly, the *Imum cœli* called *angulus terræ*, the angle of the earth, and ſignifieth contrarye to the mydde heauen.

But nowe to the matter againe: the horoſcope or aſcendent is the degree of the eclipticke ryſing vppon the horrizon at any time propoſed, or in the beginning of any thing, and chiefly in the natiuitie of a man, and is very eaſily founde by helpe of the *Reete* thus.

Place the degree of the Sunne in the Zodiack, vnto the houre propoſed by helpe of the rule applied to the *limbe*, and ſtreight looke what degre of the Zodiacke, cutteth your horrizon on the Eaſt, the ſame is the aſcendent, and the degree cutting on the VVeſt, the deſcendent.

Example.

Admit a childe were borne the 12. of October 1580. at eight of the clocke at night in our latitude, and that you woulde knowe the aſcendent of this natiuitie. The Sun was then in the 29. degree 10. minutes of ♎, whiche degree, lay vnto eight. of the clocke among the afternoone houres in the *limbe*, and then looke vnto the 51$\frac{2}{3}$. horrizon what degree cutteth him on the Eaſt part, I finde the 1. degree of ♋, whiche is the aſcendent. In this example, the North halfe of the Zodiacke croſſeth both the North and the South parts of the horrizon, but becauſe it is not the North halfe of the Zodiacke that riſeth on the horrizon, therfore you muſt take the degree which lyeth on the Northeaſt part of the horrizon, which is as I ſaye, 1. degree of ♋. For on the South part of the horrizon, there lieth the 10. degree of ♉. whiche is not too bee accounted of. But to proceede further in the example you may alſo (the degree of the Sunne ſtanding at eight of the clocke as before) ſee the firſt degree of ♍, in the VVeſt parte of the horrizon deſcendente, where alſo the South halfe of the Zodiacke lyeth croſſe both halfes of the horriſon, ſo that the tenth degree of ♏, cutteth the North parte of the horriſon, whiche muſte bee refuſed, remembrynge alwayes that the North halfe

of

of the Zodiacke muſt cut the North halfe of the horizons, and riſe and ſet on them, and no other, & ſo likewiſe, the South, on the South, as is ſhewed in the ſecond booke & 23. Chapter. Further hauing thus the aſcendent and deſcendent, you may alſo ſee the degree of midde heauen or culmination in the vpper part of the noone line $24\frac{2}{3}$. in ♒, and in the lower part, the degree of *Imum cœli*, or the angle of the earth, the $24\frac{2}{3}$. of ♌, and ſo haue you the foure angles or principall houſes of your figure for that natiuitie vz. the 1. 4. 7. & 10. houſes.

Chapter 43.

How to finde the horoſcope or aſcendent another way by the Mater.

Gemma Friſius 51.

FIrſt get the degree of culmination for the houre and time propoſed by the 29. and his meridian altitude by the 31. Next the quantitie of the angle, which the ecliptick in that degree maketh with the meridian by the 39. and 40. Theſe had, number in the *Limbe*, the alt. of the deg. of culmin. from the Pole towards the Equinoctiall, and thereto lay the rule. Then in the Equinoctiall line from the *Limbe* in wardes reckon the quantitie of the ſaide angle, founde by the 39. and 40. and from that place following the houre line there, vnto the rule, and from the rule vnto the pole: note the degrees contained on the ſame houre line, betweene the pole and the rule, for thoſe are the degrees of the Zodiacke contained betweene the degrees of culmination, and the neereſt part of the horizon. For you muſt vnderſtande that notwithſtanding the horizon and the ecliptick, beeing both great circles of the ſphere, doe alwayes deuide one another into equall partes, yet is not the degree of *medium cœli* or culmination, iuſt in the middeſt of the halfe Zodiacke aboue the horizon, but onely when ♋ or ♍. are in the meridian by reaſon of the obliquitie of the Zodiacke: but is diuided by the meridian into vnequall portions, whereof the leſſe this chapter findeth out. But ſometime the leſſer portion is on the Eaſt part, and ſometime on the VVeſt, and is thus knowne. For when ♋ is on the Eaſt part the leſſer portion is on the VVeſt, and then muſt thoſe degrees bee ſubducted out of the degree of culmination, and when ♋ is on the VVeſt, the leſſer portion is on the Eaſt, & then thoſe degrees muſt be added and thereof commeth the horoſcope.

Example.

In our latitude of $51\frac{2}{3}$. admit the Sunne to bee in the 20. of ♉, and the degree of culmination at the houre propoſed to bee 20. in ♋, whoſe meridian height by the 31. is $60\frac{1}{2}$. degrees: the angle of inclination of the Ecliptick to the meridian in that degree is 82. by the 40. Theſe knowen number in the *limbe* from the pole downewardes, the meridian altitude vid. $60\frac{1}{2}$. and thereto lay the rule, then reckon on the equinoctiall from the *limbe* inwardes the quantitie of the angle of inclination, videlicet, 82. which lighteth on the 82. houre line reckoned from the *limbe*, wherefore reckon the degrees vpon the ſame 82. houre line betweene the rule and the pole, and you ſhall finde $85\frac{1}{3}$. which is the diſtaunce betweene the *medium cœli* or culmination, & the parte of the horizon next it. And now becauſe ♋ was on the VVeſt part, you muſt adde this $85\frac{1}{3}$. to the degree of culminatiõ, vz. the 20. of ♋, & ſo proceeding according to the ſequele of the ſignes. the numeratiõ falleth on the $15\frac{1}{3}$. ♎, which is the aſcendent ſought for. Thus haue you two wayes to come by the aſcendent, the firſt eaſier, but this more artificiall by the reaſons of ſpericall triangles, and by my fift booke may be perfor-med two or three wayes.

Chapter 44.

Of the twelue houſes, and what a circle of poſition is.

Gemma Friſius. 32.

ANtiquitie which ought to be imbraced, hath appointed 12. houſes or places, wherein the ſtarres & planets haue great powers, of which 12. the 4. angles or *cardines* are chiefeſt. For euen as the Suns recourſe doth not only alter the yeere beyng in the two equinoctiall points and ſolſtices, but alſo in euery of the 12. ſignes, which cauſeth euery moneth to differ from other: euen ſo reaſon and experience teacheth in diſtinguiſhyng the 12. houſes. But now all writers agree in ſetting out the 4. *cardines*, and greatly diſagree in the other 8. For ſome beginning from the aſcendent, deuide the Zodiacke into 12. equall partes by circles meetyng together at the poles of the Zodiacke, and to theſe doth Ptolomeus agree. Otherſome deuide the equinoctiall by circles from the poles of the world into 12. equall partes, as Alkabitius, & Iohannes de Saxonia. Otherſome (which in deed is the beſt) according to Regiomontanus, deuide the equinoctiall into 12. equall parts, by circles meeting together at the two interſections of the meridian with the horizon, and this way ſayth he, ſtandeth with moſt reaſon, ſince they are diſtinguiſhed by circles, like vnto thoſe which appoint the 4. *cardines*, and meeting together with them at the ſame points. A fourth way did Campanus a famous mathematician appointe, deuiding the verticall circle of the Eaſt into twelue equall partes from the ſaid interſection of the meridian with the horizon. VVel, howſoeuer the houſes bee deuided, thoſe circles which diſtinguiſh them, or rather ſemicircles (for twelue ſemicircles do perfourme it) are called circles of poſition and the like ſemicircles may bee drawen by anye ſtarre, degree, or poynt of the heauen, and are called alſo circles of poſition. Therefore in ſhort, a circle of poſition according too *Io. Regiomontanus*, whome wee meane to followe, for that all menne nowe doe ſo, is a ſemicircle paſsing from the twoo interſections of

the horrizon with the meridian by any ſtarre, degree or point in the heauens. Notwithſtanding by the *Iewell* we ſhall teach to perfourme them to euery mans minde.

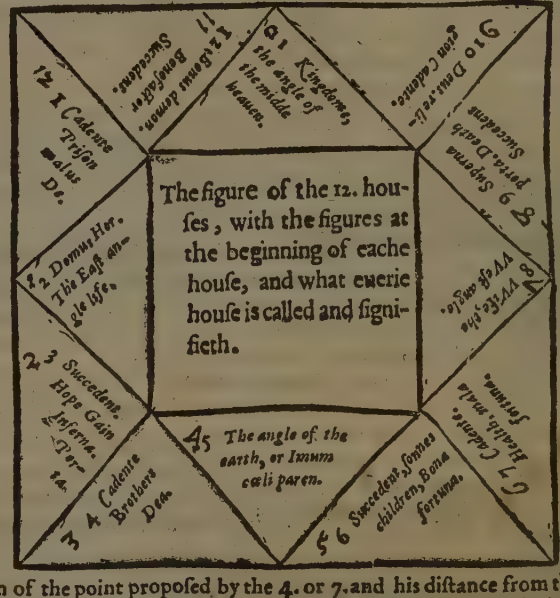
But nowe for the order of the 12. houſes, therein they all agree. The firſt houſe beginneth in the aſcendent, and ſo proceedeth vnder the earth, and the reſt in order by the *Imum cœli* vntoo the deſcendent, and thence by the *medium cœli* vnto the aſcendent againe, where the 12. houſes end. Euerye houſe hath 25. degrees forwardes, and fiue degrees of the houſe that went before. Alſo the 12. houſes are ſet downe in a Geometricall figure, as you ſee here to gether with their properties.

Chapter 45.

To finde the circle of poſition according to Io. Regiomontanus *and* Campanus, *of any point propoſed, and howe much the pole is eleuated aboue any ſuch circle.*

Gemma Friſius 53.

IT is ſhewed in the laſt chapter what a circle of poſition is. They are alſo as it were certaine Horizons, vpon the which the point or ſtarre propoſed doth ariſe. And in truth euery of them doth repreſent ſome one horriſon in the worlde, whoſe latitude, or poles eleuation wee ſeeke, and ſo by ſphericall reaſon wee finde, what degree of the eclipticke is in euery of them. And therefore generally thus doe:



Get the declination of the point propoſed by the 4. or 7. and his diſtance from the meridian by the 26. and others. This done, ſet the Eaſt Azimuth or zeneth line to the latitude in ſteed of the *Finitor*, and ſo doe the azimuthes repreſent all the circles of poſition. The zenith line beeing placed thus to the latitude, as I ſay, then in the parallel of declination of the point propoſed, reckon his houre diſtaunce, from the meridian before founde. and the azumuth there cutting, ſheweth the circle of poſition, if you count him from the Zenith line: which being had, then to knowe the poles eleuation aboue it, doe thus, reckon amongeſt the Almicantares from the Zenith point, the latitude of your countrie vpon the circle of the poſition found: and thertoo lay the rule, then reckon the ſpace between the ſame point of the circle of poſition, and the *Limbe* by the degrees of the rule, and ſo haue you the eleuation ſought for. By this chapter any man may eaſily make tables of poſitions for any countrie.

For example, in the 41. chapter I ſuppoſed a natiuitie the 12. of October 1580. at 8. of the clocke at night I woulde now knowe in what circle of poſition the Sunne then was, I lay the Zenith line to our latitude, vz. $51\frac{2}{3}$. inſteede of the *finitor*, then for 8. of the clocke. I reckon 8. houres from the South in the Sunnes parallel being $11.\frac{1}{2}$ by the 4. and there I finde to croſſe the $28\frac{1}{2}$. azimuth vnder Zenith line, whereby I conclude that the Sunne was then in the $28\frac{1}{2}$. circle of poſition vnder the earth, in the Northweſt quarter. This done, reckoning our latit. vi. $51\frac{2}{3}$. on this $28\frac{1}{2}$. azimuth, & ☽ from the zenith point found, therto lay the rule & you ſhall ſee betweene the *Limbe* and the ſame point vpon the rule 43. degrees. $\frac{1}{2}$. the poles eleuation, aboue the ſame $28\frac{1}{2}$. circle of poſition, ſome were wont to name the circles of poſition according to their latitude as that this ſhould be the $43.\frac{1}{2}$. circle of poſition.

Blagraue, Heere you may ſee the wonderfull diuerſitie in vſe of all the circles in my *Reste*. Inſomuche that at any time when ☉ is in the South meridian, as he is on the *Iewell*, then placing the Zenith line, too the latitude, the azimuthes doe ſhew the circles of poſition of euery ſtarre placed in the *Iewell*, and point in the eclipticke or other part of the heauens without any more ado, wheras by G. Friſius Curſor and Brachiolum

you

you muſt ſtand ſetting for euery particular place with much trouble. Heere note that where the Azimuthes do not reach any point, you may but turne about the *Reete* ſo that the zenithes nadir be to the latitude, and then he ſupplieth the whole.

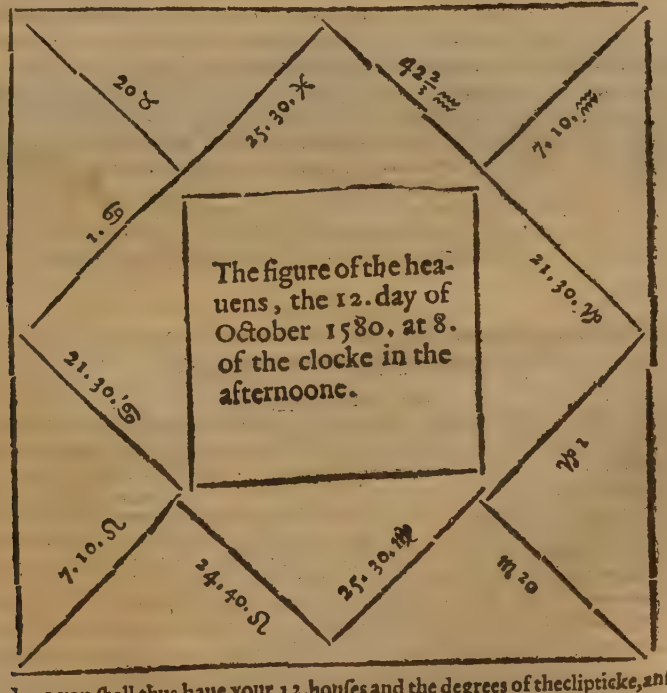
Chapter 46.

Of the other eight houſes according to Regiomontanus, and how to ſet a figure.

Gemma Friſius 54.

THe foure angles haue beene exactly taught before in the 41. and others, and the other 8. houſes alſo any man of capacitie might picke out by the laſt Chapter, but this working hath a pretie methode, which I will not hide: for you ſhall vnderſtand that all the 12. houſes are diuided with 6. whole circles of poſition, which diuide thequinoctial into 12. equal partes. Two of thoſe fixe are the horizon and the meridian which limit out the foure angles, the other 4. are two of ech ſide alike diſtant from the meridian, bending towards the horizon alike, and haue like eleuations ech to his match, and ech of them boundeth two houſes. So that euen as the meridian doth bound the midde heauen, and angle of the earth, ſo doth the circle of poſition next the meridian on theaſt part, appoint the 11. and 3. houſes, the ſecond next the horizon, the 12. & 2. likewiſe two circles on the weſt part, ſheweth the other foure houſes. Further knowe that oppoſite houſes are numbred by like degrees of oppoſite ſignes, ſo that hauing founde ſixe houſes, they are had all 12. Therefore 4. houſes knowne with the Horoſcope and midheauen, there needeth no more for this turne: & thoſe 4. are knowne if the two circles of poſition of the 12. houſes, which alſo is of the 2. & of the 11. which alſo is of the 3. be knowne by their depreſsions vnder the pole in this manner.

Place the zenith line to the latitude as in the laſt Chapt. and then marke what azimuth cutteth euery 30. deg. of thequinoctiall line, the ſame is the circle of poſition of euery ſuch houſe, to which get the eleuation of the pole by the laſt Chap. Thus reckon on thequinoctial from the *Limbe* inwards 30. deg. and there ſhal you finde to cut the 47. azimuth or circle of poſition, ſeruing to the 11. and 3. houſes, whoſe depreſsion vnder the pole by the laſt Chapter is $32\frac{1}{3}$ deg. Then reckon on thequinoctiall 30. deg. farther in, videl. 60. from the meridian, and there ſhall you finde to cut the $19\frac{3}{4}$ circle of poſition ſeruing to the 12. and 2. houſes, whoſe depreſsion vnder the pole by the laſt Chapt. is $47\frac{1}{3}$ deg. Theſe two eleuations vz. $32\frac{1}{3}$ and $47\frac{1}{3}$, keepe well in minde: for they ſerue you to get your 12. houſes for euer in our latitude: you ſhal do wel to chooſe them out among the horizons in the *Iewel*, and with prickes or otherwiſe diſſeuer them from the reſt, that you may redilie finde them, writing the number 12. and 2. to the $47\frac{1}{3}$ horizon on ech ſide, and 11. and 3. to the $32\frac{1}{3}$ horizon, for ſo I alwayes did.



Theſe things done, you ſhall thus haue your 12. houſes and the degrees of thecliptícke, anſwering them, lay the degree of culmination of the time propoſed on 6. of the clocke before noone in the *Limbe*, where he lyeth in a right line or right horizon, thenſe for the 11. houſe moue forwards the degree of culmination 30. deg. in the *Limbe*, that is vnto 8. of the clocke by helpe of the rule, then in the horizon of the 11. houſe videl. the $32\frac{1}{3}$ horizon, you ſhall finde the degree of thecliptícke, beginning the 11. houſe, as in the natiuitie mentioned in the 41. Chapt. lay the degree of culmination, being $24\frac{2}{3}$ of ♒, vnto 8. of the clocke before noone, you ſhal

ſe

see to cut the Horizon of the 11. house videl. the 32⅓ the 25½ of ♓, which is the beginning of the 11. house. Now for the 12. house I moue the deg. of Culmin. 60. deg. that is to 10. of the clock, & there do I see in the horizon of the 12. house videl. the 47⅓ the 20. deg. of ♉, which is the beginning of the 12. house, but then mouing the Culmin. to 12. of the clocke, there appeareth in our horizon videl. 51⅔ the Horoscope or ascend. videl. the 1. deg. of ♋. Now for the 2. house I moue the deg. of Culmin. 30. deg. forwards vz. vnto 2. of the clocke at the afternoone, then in the horizon of the 2. house, which is all one with the horizon of the 12. vz. the 47⅓ horizon, I see the 21½ of ♋. Then remouing the Culminat. 30. deg. farther videl. to 4. of the clock, there I finde in the horizon of 3. and 11. house videl. the 32⅓ the 7. deg. 10. minutes of ♌, the beginning of the thirde house, and nowe haue I 6. of the 12. houses. For the rest, I neede but set downe in the opposite houses, opposite signes & deg. and so is the figure set of that natiuitie, as you may here see. By this meanes you may make tables of the 12. houses to euery latitude, perhaps truer then some that are printed.

Blagraue. Note that you must in remooving the degree of Culmin. alwayes take the degree rising in the east, on the said horizons, and further that you be sure to remember, when the south signes rise, to take the deg. cutting the Southeast part of that horizon, and when North signes rise, the deg. cutting the Northeast part as in the 2. Booke 23. Chapt. and in the 41. is shewed.

Chapter 47.

Of the other eight houses, according to Campanus and Gaznlus.

Gemma Frisius 55.

He that hath well vnderstood the last 3. Chapt. neede no instructions more as I thinke, for Campanus, as is before said, deuideth the circle of the east into 12. equall parts as Regiomontanus doth the equinoct. and that also from the same opposite points of the meridian, crossing the horizon, wherefore laying the zenith line as before, to the latitude, then doth the *Finitor* represent the circle of the East, or the East azimuth being there redily diuided into all the circles of position, which the azimuthes do now represent, and euery 30. azimuth beginneth one of the 12. houses in order from the ascendent vnder the earth, and so forwards. Getting also their depressions vnder the poles in al respects as before, onely herein is the greatest difference, that you must also here get the houre distance of euery house from the meridian, which the houreline on the *mater* shew vnasked, for the zenith line standing at the latitude, you may see the 38½ houreline reckoned from the *Limbe*, to cut the 30. circle of position reckoned on the *Finitor* from the *Limbe*, and likewise the 66½ houreline to cut the 60. circle of position. The rest are distant in like deg. from the meridian, though in seuerall quarters. And where in the 45. you laid the deg. of Culmination to 30. deg. or 8. of the clocke from the east, for the 11. house, you must instede thereof lay it on the first houre distance from the meridian found vz. 38½. And in steede of remouing the Culmination to 60. deg. or 10. of the clocke, you must lay it to the second distance videl. 66½ for the 12. house, then for the 2. house reckon 66½ deg. from sixe a clocke at night towards noone, and for the 3. 38½ from the west vpwards also, for you must note that the axtree line here representeth the meridian and the nooneline or horizon after a sort, in working.

Blagraue. I leaue out here an example because it differeth not from the vnderstanding of the last Chap. but onely in reckening the houre distance, of the which I presume, my *Iewel* being so furnished with all needeful circles, supplieth the meaning *prima facie* without serching about the bush as Gemma Fris. doth. And as for the other kind of houses after Firmicus and Alkabitius and others, I vtterly leaue out because my *Iewel* being full fraught with al necessarie circles, as I say, yeldeth greater matters with small instruments, & also for that they are vtterly reiected, and none now in vse, but the first way after Iohn Regiomontanus.

Chapter 48.

To know in what house any starre is at any instant and to place the chiefe starres in the 12. houses.

Gemma Frisius. 56.

Some haue had a delight to place diuerse of the great starres in the figure being set, which must thus be done. Get the stars houre distance from the merid. at the instant proposed by the 30. & number the same in his parallel of declin. then set the zenith line to the latitude, as in the 2. last Chap. and looke what azimuth or rather circle of position cutteth the same point in the said parallel, as in the 44. then mark in the equinoct. line what deg that circle of position lacketh of the meridian (for euery house is 30. deg. of the equin. after Io. Regi. whom we follow). The meridian is alwayes the beginning of the 10. house, wherfore so many times 30. as the stars circle of position is distant from the meridian on the equinoct. line, so many houses it lacketh, or is beyond the 10. house: so that by knowing in which quarter of the skie the star is, the house, & part is easily reckoned.

Blagraue. He that vnderstandeth al before, needeth no example here, but thus much farther, I wil shew you as in the 45. you may plainly see that 4. circles of position with the *Finitor*, & the meridian, do shew the whole 12. houses, which are as there is said, the 47. and 19¾ azimuthes or circles of position, reckoned on ech side of the zenith line as he is there placed: wherefore if you did disseuer out with some distinction by prickes or otherwise those 4. azimuthes, and set their figures to them, namely at the zenith line, 1. because hee being the horizon beginneth the 1. house at the 19¾ azimuth vnder him: or leftwards two, for the 2. house: at the 47. azimuth 3. at the 90. which is the *Limb* 4. and so round backe againe by the same circles ending at 12. in the 19¾ azimuth aboue the zenith line. These circles being thus distinct & numbered, are in truth your 12. houses, the zenith line being at the latitude. So that nowe the star or sunnes distance from the meridian reckoned on their

parallel

parallel as aboue, make there a pricke with incke, for there is the ſonne or ſtarres place for the time being, and now in what houſe he is, the ſaid azimuthes diſtinguiſhed and figured as before, ſheewe without asking. This could neuer be done by G. Friſius Aſtrolabe in this manner.

A ſhort example: the ſunne being in the tropicke of ♋, I would know in what houſe he is at 7. of the clock before noone. I ſet the zenith line in ſteede of the *Finitor* to the latitude, and then I finde that the $27\frac{1}{2}$ circle of poſition cutteth the tropicke with the 7. a clocke houreline, which according to the numbers euen now placed ſheweth me that the ſunne is farre within the 11. houſe about $\frac{3}{4}$. neere towards the 12. Or thus more plainly, follow the ſaid $27\frac{1}{2}$ circle of poſition vnto the equinoctiall, and there doth he ſhew that the ſunne is in the 20. deg. numbred on the equin. within the 11. houſe towards the 12. that is $\frac{3}{5}$. Likewiſe I ſhewed in the 26. chap. that the great ſtarre Hircus was 4. houres and 2. deg. paſt the north meridian eaſtwards in his parallel being 45. there make a prick, & mark in what houſe he then was, you ſhal finde him in the 11. houſe ſomwhat more then halfe in.

Chapter 49.

Of directions, what direction is, and by what meanes it is performed.

Gemma Friſius 58.

TO direct ſaith Io. Regiomontanus, is no other thing elſe then to turne about the ſphere vntil the ſecond place be brought to the place of the firſt, that is to ſay, vntill the ſecond place light on the ſemicircle of poſition of the firſt, ſome haue called this prorogation, ſome inambulation, ſome *Apheſin*. I thinke it rather ſaith G. Friſius *Dimiſſion*, or *Emiſſion*, becauſe one place of the heauens by turning of the ſphere is emiſed or ſent forth vnto the ſite of another place. Whereby Ptolomeus doth call thoſe places which hee termeth chiefe, that is to ſay, thoſe which may receiue, the chiefe ſignifiers of our life, and adde power to thoſe ſignifiers *Topous Apheticous*: and alſo calleth thoſe ſignifiers *Aphetæ*, as it were Dimiſſaries, or Emiſſaries. The Arabians call them *Hylech Philippus*, prorogators. To be ſhort, *Aphetæ* called commonly both in latin & engliſh, *Significator*, or ſignifier, is either a ſtar, or ſome notable place in the heauens, hauing the chiefeſt dominion ouer the life of man, and Ptolomeus hath 4. almoſt, the Sun, Moone, the pars Fortune, & the Horoſcope. There be other places alſo accepted of authors, as the midheauen, and any planet hauing gotten ſome notable dominion: and are called *Aphetæ* and ſignifiers, vnto whom other places of the planets, or places filled with the beames of planets are dimiſed or ſent, that is to ſay, dyrected.

For declaration hereof, take G. F. own example of the natiuity of King Philip, ſomtime huſband to Queene Marie. He was born 1527. at a quart. paſt 4. of the cloke in the afternoone, the ſun being 9. deg. in ♊, & the lat. of the country being 40. The figure thereof being ſet there, is found $2\frac{1}{2}$ deg. of ♍ in the aſcendent, and in the midheauen $8\frac{1}{2}$ deg. of ♌. And now to the purpoſe, the Horoſcope is alwayes a notable place. For hence do they take their iudgement of the helth of the body, of life, and of iourneying, wherefore it is called *Aphetæ*, or a ſignifier. And Mars which then was in the 2. houſe, is called the promiſer, & the 2. place, which by the motion of the ſphere is brought vnto the firſt place, that is to ſay, vnto the horizon which is the circle of poſition of the horoſcope, & this is called direction or emiſsion. The queſtion is chiefly how many deg. of the equinoct. ſhall paſſe ouer the circle of the horizon or the meridian, in the meane time, while the place of ♂ be brought vnto the place of the *Aphetæ*. For it is ſignified that there are ſo many yeres to come before the effect of the promiſer ſhalbe performed on the *Aphetæ*. This matter is eaſily done by the *Iewel* for any region or point of the heauens. Seeke the circle of poſition of the firſt place or ſignifier, and his horizon by the 44. and 45. or rather 47. and vpon the ſame horizon lay the deg. of the *Aphetæ* in the zodiacke, and marke then what deg. is in the midheauen. And then turne about the *Reete* vntil the 2. place of the promiſer come to the ſame horizon of the ſignifier, by and by moue the rule vnto the deg. which before was in the midheauen, it ſheweth on the *Limbe* the degrees paſſed of the equinoctiall, which ſignifie the yeares of the direction.

As in the ſaid example, place the Horoſcope being the ſignifier of life vnto his circle of poſition, that is, vnto the 40 horizon, you ſhal ſee on the line of midheauen ♌ $8\frac{1}{2}$ deg. then turning the *Reete* vntill the place of ♂ which then after Alphonſus, was in the 29. deg 17. min. of ♍ be brought vnto the ſame 40 horizon, and then ſetting the rule vnto the 8. deg. 30. min of ♌, you may ſee that the *Reete* hath gon forwards on the *Limbe* 34. deg. $\frac{1}{2}$ almoſt, and ſo many are the deg. of emiſsion or direction of ♂ vnto the horizon. But heere muſt you diligently note that for Aphetaes placed in theaſt halfe of the heauens, that the horizons be taken on theaſt part of the *Iewel*, & for thoſe of the weſt halfe, on the the weſt part, the reſt may be performed as before. Neither muſt you here neglect the latitudes and declinations of the planets, for which I taught you remedie in my addition to the 23. Chapt. And here another way to remedie the latitude of any planet, is thus: Get the deg. of right aſcen. and thereto lay the rule, whereon reckon his declination from the *Limbe* inwards & there is the true place of the planet: this rule alſo ſerueth for all ſtars not being in the *Reete*, and alſo for ſtarres in the *Reete* in workings for time long paſſed or to come, becauſe fixed ſtarres go forwards in long. a deg. at the leaſt, in an. 100. yeares.

Chapter 50.

Of conuerſe or euerſe direction, or dimiſsion.

Gemma Friſius 59.

WHen as the ſignifier is on theaſt part Ptolomeus, always emiſeth or bringeth the 2. place vnto the firſt circle or place, or to the Aphetaes place, & reckoneth the deg. paſt in the meane time. And this he calleth proiection of beames, becauſe that either the planets places or their beames are brought vnto the Aphetaes place, and this is called direct, becauſe the ſecond place differeth from the firſt according to the ſequeale of the ſignes. But when the *Aphetæ* differeth from the midheauen towards the VVeſt, the ſeconde place ſhall be the VVeſt it ſelfe, and then ſhall the *Aphetæ* bee brought vnto the VVeſt part of the horizon

to

to know the direction of the *Apheta* vnto the Anareta, called Interfector, and is faide to be contrarie to the order of the fignes, becauſe the ſecond place, that is to ſay, the deſcendent or point of the weſt, which then is the Anareta, is diſtant from the firſt, contrarie to the order of the ſignes. Of the firſt manner is ſpoken in the laſt Chap. Of the latter there needeth not many words, for it is euen like. For the deg. of midheauen being placed in the nooneline, turne the *Reete* till the *Apheta* be brought to the deſcendent, and then the rule laid to the deg. which was in midheauen, you may ſee howemany deg. the ſphere hath now gon forwards which are the degrees of the direction.

Chapter 51.

How farre, or into what part of the zodiacke, Dymiſsion or direction ſhall come any yeare.

Gemma Friſius 60.

IT hath beene plainely and exquiſitely ſhewed in what time the Dymiſsion or direction of any place is performed. But oftentimes the queſtion is before al the Dymiſsion be performed, into what deg. of the zodiack the direction ſhall come, and he that hath wel vnderſtood the premiſes, ſhal performe this Chapt. with little adoe: for the queſtion it ſelfe hath a certaine difficultie by the manner of pronuntiation, which I thinke beſt firſt to expound, for many either pronounce ill, or elſe vnderſtand not the matter wel: for whē as we ſay, how farre commeth the direction of the Horiſcope this yeare. It ſeemeth to be vnderſtoode that the Horoſcope (which now we cal the *Apheta*) ſhould be moued in the heauens: but the matter is otherwiſe when the *Apheta* is in theaſt part. For then we do not emit or ſend forth the Horoſcope, or any *Apheta*, but do mooue the places following, or promiſers vnto him. Therefore when it is demaunded how farre the emiſsion of the *Apheta* placed on theaſt part, hath gone forwards: the queſtion is, what deg. of the zodiacke ſhal come vnto the ſemicircle of the *Apheta* in this or that yeare. But the *Apheta* ſtanding on the Weſt part: It is more rightly ſaid that his Dymiſsion doth occupie this or that deg. of thecliptcke, becauſe the *Apheta* is knowne to be moued towards the Weſt. Now therefore togither with an example will we explane the matter.

Firſt in direct direction. Therefore in the natiuitie of king Philip, let vs appoint the *Apheta* to be the Horoſcope it ſelfe, let vs ſee then vnto what degree of the zodiacke the Dymiſsion, or direction ſhall come that yeare 1554. that is to ſay, what part of the zodiack ſhal then come vnto the Horizon circle by Dymiſsion vid. vnto the *Aphetaes* place. Firſt conſider how many yeares be paſſed from the natiuitie it ſelfe, which are 27. for he was born, anno 1527. Secondly, place the *Apheta* vnto his place, which is the Horizon, & note the deg. of culmination, then remoue the ſame deg. of culmination 27. degrees forwards in the *Limbe*, and there ſhall appeare in the 40. horizon ♏ 23. deg. 40. minutes almoſt, therefore this deg. of the zodiacke then commeth vnto the Horoſcope.

But now let the *Apheta* be in the weſt part of the heauens, as the part of Fortune is in the ſaid natiuitie, let vs ſeeke his Dimiſsion for the ſame yeare 1554. place the deg. of Culmination in the midheauen videl. ♌, 8. deg. 30. minutes: and numbering thence 27. deg. in the *Limbe*, and thereto laying the rule, place there the degree of Culmin. videl. the $8\frac{1}{2}$ of ♌. Now then marke diligently the diſtance of the part of Fortune from the ſouth, numbering the degree of the *Limb* betweene the nooneline and the rule placed on the part of Fortune. In our example they are 45. deg. 45. minutes almoſt, with this diſtance therefore, and the declination of the *Apheta* found before videl. 22. deg. 25. minutes north, ſeeke the circle of poſition of the ſame *Apheta* for that time, and theleuation to it, and how many degrees of thequinoctiall the ſame ſemicircle is diſtant from the meridian. Therefore by the 44. or 47. Chapt. the circle of poſition is found diſtant from the meridian in theaſt circle 41. deg. 48. minut. Theleuation of the pole is 25. 40. The ſame ſemicircle doth cutte off from the weſt quadrant of thequinoctiall 34. deg. 30. minutes as neere as may be gathered by a ſmall inſtrument. Now therefore we haue the circle of poſition of the part of Fortune for 27. yeares paſſed, the queſtion now is, what deg. of thecliptcke was in this circle of poſition in the beginning of this natiuitie. For it may rightly be ſaid that the Dymiſsion or direction of the part of Fortune is come vnto it. But ſeeing this is a generall rule, it is better to ſhew it in a Chap. following.

Chapter 52.

To finde what degree of thecliptcke occupieth any circle of poſition at any time.

Gemma Friſius 61.

THis Chapter is very commodious, yet comberſome by tables, & therefore the more pleaſant by the *Iewel*, it is but in effect the 45. and 46. euerſed. Get the circle of poſitions eleuation by the 45 and his diſtance from the meridian, as in the 47. Theſe had if the circle of poſition, ſhall be oriental and nocturnall (that is) vnder the earth, reckon on the *Limbe* his diſtance from the meridian found, from theaſt point towards midnight, and thereto lay the deg. of *Imum cæli*, or the angle of the arch, if orientall and diurnall then towards noone, and there lay the Culmination, if occidentall and noct. then from the VVeſt towards midnight and there lay the *Imum cæli*, if there diurnal, towards noone, and there lay the degree of Culmination as in the 46. Chapt. And ſo the deg. of thecliptcke cutting the circle of poſitions horizon is your deſire.

Example. Admit the ſunne be in $8\frac{1}{2}$ deg. of ♏ the *Medium cæli*, or Culmination, then $6\frac{1}{2}$ of ♈. the *Imum cæli* or angle of the earth $6\frac{1}{2}$ of ♎, theleuation of the 48. poſition vnder the arth eaſtwards, being by the 44. $31\frac{2}{3}$ his diſtance from the meridian $29\frac{1}{2}$, which I reckon from theaſt towards midnight on the *Limbe*, and thereto lay the deg. of *Imum cæli* videl. $6\frac{1}{2}$ of ♎ then looking on theaſt part of the $31\frac{2}{3}$ horizon, I finde there the $10\frac{5}{6}$ of ♐, the deg. of thecliptick, occupying the 48. circle of poſition nocturnal. Likewiſe for the 48. poſition diurnall Eaſtwards the deg. of culmin. videl. $6\frac{1}{2}$ of ♈, laid $29\frac{1}{2}$ deg. towards noone, you ſhall finde in the ſame $31\frac{1}{2}$ horizon $18\frac{2}{3}$ of ♉, remembring alwayes to looke on the North Horizon for north ſignes, & ſo contrariwiſe, as in the 2. Booke and 23. Chapt. Looke farther the 4. Booke.

Chap

Chapter 53.

To know the quantity of the angle of the inclination of the Eclipticke to the horizon at any degree of the Eclipticke.

Gemma Frisius. 62.

THis chap. is very profitable about the occultations and appearing of starres, and also for the deformation of Eclipses. First therfore place the deg. proposed vnto the horizon on the East, then reckon the degrees of the Eclipticke betweene the ascendent and midheauen, if they exceede 90. then take the deg. betweene the midheauen, and the descendent, or take the first out of 180. all is one: next get the meridian altitude of the degrees of midheauen. These had, reckon on the rule that distaunce betweene the horizon and mydheauen outwards from the centre, and moue the rule vp and downe till the same poynt do cut the parallel answerable to the height of midheauen, and so doth the rule shew in the *Limbe*, reckoning from the Equinoctiall the quantity of the angle sought for: which is also the lesser angle, as in the 39. and therfore subducted out of 180. leaueth the greater, and this lesser angle is alwaies the height of the Eclipticke 90. deg. or *nonagesi. gradus* from the horizon.

Example. In the yere of our Lord 1590. the 20. of Iuly the 19. houre 30. min. which is at halfe an houre past 7. the next morning (for Astronomers begin the day at noone, and reckon agayne til noone vnto 24. in their tables) there shall be a great Eclipse of the Sun, the Sun and moone both being in coniunction in the $7\frac{1}{2}$. deg. of ♌: wherefore placing the deg. of the sun vnto $7.\frac{1}{2}$. of the clocke 30. min. I see $10.\frac{2}{3}$. of ♍ in the ascendent, and in the descendent $10\frac{2}{3}$. of ♓, and in the mydheauen 4. in ♊, I would now know the quantytie of the lesser angle made betweene the Eclipticke and the horizon. From the ascendent to the mydheauen, are $96\frac{2}{3}$. deg. take those out of 180. there resteth $83.\frac{1}{3}$. the meridian altitude of the degree of culmination, vz. of 4. of ♊, by the 28. is $59.\frac{1}{2}$. deg. This done, reckon the degrees betweene the midheauen and the descendent, vz. $83\frac{1}{3}$. on the rule from the centre, and lay the same degree on the $59\frac{1}{2}$. parallel, & so doeth the rule shew in the *Limbe*, reckoning from the Equinoctiall 60. deg. the quantity of the angle sought for, which is the height of the *nonagesi. grad.* or 90. deg. of the Eclipticke aboue the horizon.

By this angle many things are brought about, as shalbe touched hereafter.

Blagraue. It may be that Gemma Frisius tooke the course before about this chap. for better vnderstanding of the chap. following, or els I must say hee ouerslipt another more easie way, as hee himselfe saieth, learned men do many times, which I wil here shew you.

Place the deg. at which you require the angle, to be ascendent: thence reckon vpwards 20. deg. on the Zodiacke, therto lay the rule, which sheweth in the *Limbe* the distance of that 90. deg. from the South by the 30. and betweene the *Limbe* and this 90. deg. of the Zodiacke, rckoning on the rule, is the declination thereof by my addition to the 4. chapter. These had, seeke on the *Mater* where this declination and distaunce do crosse by the 26. and the Almicantare (the *Finitor* beyng at the latitude) cutting there, sheweth the angle sought for.

As in example before, the $10\frac{2}{3}$. of ♍, being ascendent, I reckon on the Zodiacke vpwards 90. deg. it lighteth on the $10\frac{2}{3}$ of ♊, thereto I lay the rule, where I finde the distance of the same $10\frac{2}{3}$. of ♊, from the south to be 7. deg. $\frac{1}{4}$. and his declination by reckoning the deg. on the rule betweene it and the *Limbe*, to be 22. and better, North. These two being had, I set the *Finitor* to the latitude, and then marke where the $7\frac{1}{4}$. houre line reckoned from the *Limbe*, and the 22. parallel do crosse, and there I see cutteth the 60. almicantare, as before, the angle sought for, with lesse trouble.

Chapter 54.

How to finde the altitude of the Sun or any point of the Ecliptick aboue the horizon at any time otherwise then hath yet bin shewed.

Gemma Frisius 63.

THe houre giuen, with the Sunnes place: the ascendent is knowen by the 41. and by the 52. the altitude of the *nonag. grad.* or 90. degrees from the horizon, which I reckon of the *Limbe* on the *Reete*, and thereto lay the labell: this done, note how many degrees the Sun, or point giuen, is from the ascendent or descendent, so many deg. reckon on the rule from the centre, where the Almicantare cutting, sheweth the altitude sought for.

As in the example of the last chap. the houre being 7. and 30. min. the ascendent thereby $10\frac{2}{3}$. of ♍, and so the altitude of the 90. degree 60. VVherefore these being had, I would also know the altitude of the Sunne at that instant, being then as is saide in the $7\frac{1}{2}$. of ♍, to perform this, I reckon in the *Limbe* or vttermost azimuth of my *Reete*, the altitude of the 90. deg. of the Eclipticke, vz. 60. deg. and thereto lay the *Labell*, then I reckon on the *Label*, from the centre the space between the ascendent, videl. $10\frac{2}{3}$. ♍, & the suns place, vz. ♌ $7\frac{1}{2}$. whiche is 33 deg. $\frac{1}{4}$. And there do I see the $28\frac{1}{3}$. almicantare to cut the *Label*, which is the height of the sunne for the time of that Eclipse. In like maner may you come to the height for that instant, of any deg. of the eclipticke by their distance from the ascendent or descendent, the *Labell* standing still there which in calculating the Eclipses standeth in great steede.

Chapter 55.

To find what angles the circle of altitude maketh with the Eclipticke at any point thereof assigned.

Gemma Frisius 64.

THis chap. serueth chiefly to descry the sunnes Eclipses, wherein is almost the greatest labour and diffyculty of Astronomie and Arithmeticke but shal be easily performed by helpe of this *Iewel*. First note that Gemma Frisius meaneth by the circle of altitude, the vertical circle or azimuth, wherein the sun or any other deg. proposed, is. Then to proceede, gette the distaunce of the point proposed from the zenith, by subducting his height learned by the last chap. out of 90. Likewise learne by the 52. the distance of the *nonagesi. grad.* or 90. deg. of the Eclipt. from the zenith: these 2. being known. reckon the greater of these on the rule from the centre, & then moue that note on the rule vnto the paral. of the lesser distance, and so doth the rule shew in the *Limbe* the quantity of the angle, reckoning from the Equinoct. As if in the last question of the Eclipse, I wold know of the angle which the circle of altitude passing by the Sun, doth make with the Eclipt. I seeke the distaunce of the Sun from the zenith, by subducting $28\frac{1}{3}$. from 90. $61\frac{2}{3}$. Likewise subducting the height of the 90. deg. vz. 60. from 90. there resteth 30. his distaunce from the zenith also. Now doe I reckon on the rule $61\frac{2}{3}$. deg. and there make a note which I lay vnto the 30. parallell, and so is the angle sought for, found to be $34\frac{1}{2}$. shewed on the *Limbe* by the rule.

This is alwaies one of the lesser angles, as in the 39. chapter, and is towardes the East, when the poynt of the Eclipticke assigned, is on the East part of his 90. degree, and on the VVest if otherwise. VVheretore this angle found, vz. $34.\frac{1}{2}$. subducted out of 180. there resteth $145\frac{1}{2}$. the quātity of the greater angle as in the 39.

Furthermore know this for a certain truth, that the angle found in this chap. is that which they cal the angle of latitude, because the parallaxis or diuersity of aspect, which happeneth in latitude is subtended or lyeth vnder it, and this angle if we subduct him out of 90. there shall bee left the angle which they call the angle of longitude: but whereto these belong, and to what vse they are sought, shall bee shewed here following.

Blagraue. In this chap. the Equinoctiall representeth the Ecliptick, and the rule, the vertical circle of the sun, the poynt noted in the rule the zenith, or rather the like distaunce from the Sunne: the other way or downwards the centre of the *Iewell* representeth the point of intersection with the sunne: the line between the note in the rule (which as I saide is the zenith) and the Equinoctial, is the distance betweene the zenith, and the 90. deg. but rather between the like deg. on the azimuth beneath the sun. The reasons hereof I will shew somewhat more large in my 5. booke, and omit them here, both because too much tedious matter together might cloy a young student, and also for that I meane to shew, how to find al spherical triangles on the *Iewel*, which Gemma Frisius instrument could neuer doe.

Chapter 56

How to finde the parallaxis or diuersity of the sight of the moone in the circle of altitude.

Gemma Frisius. 65.

IT is by demonstration affirmed in Ptolomeus works & other famous authors, that the globe of the earth is but a point in respect of the heauen it selfe: that is to say an vnsensible bignesse in comparison to the heauens. And that whether a man be in the centre of the earth, or on the circumference, there commeth thereby no diuersity of any apparents in the heauens: heereof it commeth that all dialles are made, as though we dwelt in the centre of the worlde, neyther hath any man found diuersity therein, were he neuer so ingenious or practick. But as these things are most true, and stand vpon good demonstration, yet in some of the planets it is not so. For although the fixed starres, and the highermost planets, because of their vnmeasurable distance from vs, make no diuersity of sight to vs, from that which is seene in the centre of the worlde: yet in the lowermost planets how much the neerer they be vnto vs, so much the more is perceiued the euariation of their place appearing from that which they haue vnto the centre of the world. For you must vnderstand that all calculations of the motions of all the starres and planets perfourmed by tables or Ephimerides, are done & made to the centre of the world. Now because the speere of the moone is neerest vnto vs, there is perceyued a manifest diuersity betweene her place, which we see dwelling here on the circumference of the earth, & her place which a line drawn from the centre of the world through the moon, doth shew: because the semidiameter of the earth, according to which quantity we dwel from the centre, hath a sensible bignesse vnto the dystaunce of the moones speere from vs. This diuersitie is perceyued not only in the moone, but also in *Mercury* and *Venus*, and somewhat in the sunne, though verye little, and scarce perceiuable: this diuersity of sight called of *Ptolomeus*, *Parallaxis*, is greatest in the moone: in the rest it is almost neglected, neither is it alwaies alike in the moone: which is a sure argument that the moone is not carried in Homocentre speeres, as some woulde haue auouched. But how much the more the moone departed from the centre of the world, and becommeth *Apogea*, so much the lesse happeneth this parallaxis, and how much the neerer she commeth to the earth being *Hypogea*, so much the greater is this parall. so that the greatest parallaxis of all, is one degr. 6. min. And the least which happeneth, the moon being in perig. is but 50. min. omitting a few seconds: in the sunn this parall. is 3. min. onely. This parallaxis, when it is simply spoken of, it is meant the moone or planet beyng in the *Finitor* or horizon, in the zenith they can haue no parallaxis: for there the beame proceeding from our sight, is all one with that which commeth from the centre of the world, but the more neere to the horizon, the greater. These things are plaine to those that vnderstand the theorickes, and are excellently demonstrated by Ptolomeus.

Parallaxis.

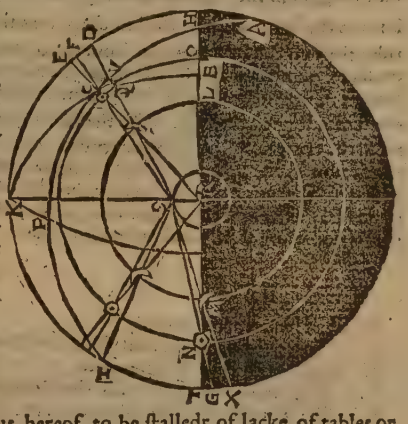
The scope therefore of this chap. is by the greatest horizontall parallaxis, giuen how to get the parallaxis of the moone for the altitude she is in.

Gette therefore out of some tables of Eclipses, or out of Copernicus, the moones greatest or horyzontall

ontall parallaxis for the ſight, ſhe is in her ſpeeres, and likewiſe the moones height aboue the horizon by the firſt or 32. though commonly in an Eclipſe, ſhe differeth not from the ſunnes height. Then number the horizontall parallaxis on the *Limbe* from the Equinoctiall vpward, and therto lay the rule: which done, reckon on the rule from the centre, the moones diſtãce frõ the zenith, or inwards from the *Limbe* the moones altitude all is one, the parallel cutting the rule there ſheweth your deſire.

This inſtitution bicauſe it is moſt pleaſant, by the which not without admiration of moſt men, Eclipſes are prognoſticated long time before they happen, deſerueth an example.

As in the Eclipſe like to be 1590. mentioned in the 50. chap. the ſun & the moone ſhall be in the $7\frac{1}{2}$. de. of ♌, this I ſay is their place calculated to the centre of the world: in the which luminaries ſhalbe coniun. Now therefore the queſtion is, what the ſun & moones viſible place ſhalbe, thereby to gather the euariation of the Eclipſe. For by reaſon of the euariation of the ſight or parallax. they ſhall not be ſeene here coniunct, as they are found to be in reſpect of the centre of the world: the altitude of the ☾ is found $28\frac{1}{3}$. as well her latitude being 20. min. North, as her longitude accounted of, the greateſt parallaxis I found 52. min. Therfore in the *Limbe* I number not 52. min. as I ſhould doe, but I reckon 5. deg. $\frac{1}{4}$. almoſt: ſo that ech deg. ſupplieth 10. min. the 5. deg. being here for the 50. min. and the other $\frac{1}{4}$. almoſt for 2. min, which is done becauſe els a huge inſtrument would be too little to perform this matter exactly. The rule being ſo ſet at $5\frac{1}{4}$. deg. almoſt, I reckon inwards thereon the height of the moone. vz. $28\frac{1}{3}$. and there I ſee to croſſe the rule the $4\frac{1}{2}$. parallel, now taking for ech of the 4. parallel 10. min. and for the half 5. min. there commeth 45. min. the moones parallaxis according to that height and place: that is to ſay, the moone ſhall be ſeene here 45. min. lower then in truth ſhe is, in reſpect of the centre of the world in that Eclipſe.



Likewiſe appointing 5. deg. for 3. min. the greateſt parallax. of the ſun, euery deg. is 40. ſecondes: there place the rule, & reckon the ſaid $28\frac{1}{3}$. deg. inwards it ſheweth the $4\frac{1}{4}$. parallel, whiche commeth to 8. ſcore and ten, or 170. ſeconds, deuide that by 60. there commeth 2. min. & 50. ſeconds, the parallaxis of the ſun. Here you muſt take heed that you ſeeke not to work greater angles in this manner: and in theſe leſſer, that you exceede not 10. deg. on the *Limbe*: for this eaſe ſerueth but in ſmall angles, where the queſtion is of minutes, which in greater wil not holde proportion, but if a third or 4. part of a minute be wanting, the errour is not much, but ſo much of a degree is not allowable.

Blagraue. Gemma Friſius ſaith before in this chap. that the moones greateſt horizontall parallaxis is 1. deg. 6. min. beeyng in her Perigeon, and that the leaſt horizontall parallaxis is the moone being in her Apogeon 50. min. For the reſt he referreth you to tables. But now becauſe I woulde not haue any deſirous hereof, to be ſtalledr of lacke of tables or ſight in the Theorickes: I will ſhew you after a blunt ſort how to gette the horizontall paral. of the moone according to her ſight between her apogeon and perigeon, by helpe of an Almanacke.

Firſt I would haue you vnderſtand that at euery change and full of the moone, ſhe is in, or very neere her apogeon, and at euery quarter in, or neere her perigion, therefore when as if it be true as Gemma Friſius ſaieth, that the greateſt paral. in the perigeon is 1. degree 6. min. and the leaſt in the apogeon 50. min. ſubducting the leſſe from the greater, there reſteth 16. min. the difference. The ſpace of time betweene the quarter and full, or change, is 7. dayes, 9. houres or thereabouts, which maketh 177. houres, but account it here (for it hurteth not greatly) 180. houres. Now therefore this knowen, reckon the difference of theſe horizontall paral. vz. 16. min. on the *Limbe* from the Equinoctiall, or rather as you were wont 8. deg. ſo euery deg. repreſenteth 2. min. thereto lay the rule: and by helpe of an Almanacke learne howe many houres the moone is diſtaunt from the next ful or change, and reckon on the rule for euery two of thoſe houres one deg. on the rule from the *Limbe* inwards, and there marke what parallel cutteth: for it ſheweth the minutes to be added to the moones leaſt horizontall paralaxis, videlicet 50. I would needes knowe her horizontall parallaxis, I looked in the almnacke, and there I ſawe ſhe was at the full the 22. of October, at 6. of the clocke at nighte. I caſte howe many houres were paſſed and found 50. houres, then laying the rule on 8. deg. in the *Limbe*, which here repreſent ech 2. minutes. I reckoned thereon from the *Limbe* inwardes, for thoſe 50. houres 25. deg. there I ſaw the $7\frac{1}{4}$. parallel to cut, which here repreſenteth but $14\frac{1}{2}$. min. to be added to 50. it maketh $64\frac{1}{2}$. min. or 1. deg. $4\frac{1}{2}$. min. the horizontal parallaxis for the time ſought for. VVhich being had, I might therby as before get the moones parallaxis for the height, ſhe was at *ſed hæc rudieri Minerua*, by reaſon of the moones Epicicle, which cauſeth ſome errour.

Chapter 57.

How to finde the parallaxis of the moone or any other planet, or ſtarre in longitude and latitude of the Eclipticke.

Gemma Friſius 66.

THE parallaxis beyng now found in the circle of altitude, in whiche circle his muſt needes happen: You

ſhall vnderſtand that ſometime it happeneth in longitude, whereby the ſtarres ſeem to haue another longitude then is found in tables calculated to the centre of the world, inſomuch that if the ſtarre ſhalbe from the aſcendent, leſſe then 90. deg. he ſhal ſeem to haue a greater longit. thē in truth he hath, but being ſituate VVeſtwardes from the 90. degree he appeareth to ſight in leſſe longitude: but in the middeſt or 90. deg. of the Eclipticke, he maketh no parallaxis in longitude, but all in latitude. For then the circle of altitude is all one wyth the cyrcle of Longitude of the ſtarre yſſuyng from the pole of the Zodiacke by the Zenyth. But when the parallaxis falleth wholly in Latitude then the Eclipticke muſte of neceſſitye cutte the Zenith and bee made one circle with the circle of altitude, this happeneth only to them that dwel either vnder one of the Tropickes, or betweene both. In other places the parallaxis doeth partly alter the longitude, and partly the latitude, ſo that the neerer the moone ſhal be to the 90. deg. of the Eclipticke, ſo much the greater is the parallaxis of latitude and of the longitude leſſe: and contrariwiſe the further ſhe is from the 90. degree, the greater is the parallax of longitude, and the leſſe of latitude. And how much either of them is, may thus be had.

Seeke by the 54. the angle which the circle of altitude maketh with the Ecliptick in the place of the moon or of the ſun: and by the laſt chapt. the parallaxis in the circle of altitude, reckon the quantity of the angle on the *Limbe* from the Equinoctial, and thereto lay the rule, then on the rule from the centre outwards, reckon the parallaxis found by the laſt chap. reckoning for euery 5. minutes therof one deg. on the rule, as you there did on the *Limbe*, the parallel cutting there, ſheweth the parallaxis of latitude, accounting accordingly euery parallel for 5. min. Likewiſe following the houre line cutting the point of the rule with the ſame parallel vnto the Equinoctial line: it ſheweth the parallaxis of long. reckoning from the centre, taking euery houre line for 5. min. alſo. As in the 54. chap. the angle of the Eclipticke with the circle of altitude was found $34\frac{1}{2}$, the parallaxis in the ſame circle by the laſt chap. was then 45. min. I reckon on the *Limbe* $34\frac{1}{2}$ deg. and thereto lay the rule: then on the rule I reckon from the centre 45. min. or rather 9. degrees, ſo that euery deg. may heere repreſent 5. min. then doe I finde to cut the rule in that 9. degrees, the 5. parallel which here repreſenteth but 5. times 5. min. videlicet 25. ſo many min. is the parallaxis in latitude. Then following the houre line, cutting the ſaid 9. deg. of the rule, with the ſaid 5. parallel he ſheweth on the Equinoctial line $7\frac{2}{3}$ degr. reckoned from the centre, which taking euery deg. for 5. min. are 39. min. almoſt, which is the parallaxis in longitude of the moone at the time of the ſayde Eclipſe. And becauſe ſhe is then Eaſtwards from the 90. deg. therfore the longit. of the moone ſeen, is greater then the true longytude. And therby it is euident that the viſible coniunction ſhal goe before the true, ſo long time as the moone by ouergoing the Sun may get 39. min. which is the euariation of ſight or parallaxis in longitude.

Beholde this figure.

R The Centre of the world,
S The place where we dwell from the Centre.
K The Zenith, H T the horizon.
K B The circle of altitude, A, I the Eclipticke.
R E The true place of the Moone in the Eclipſe.
S D The place ſeene.
Q C The parallaxis in the circle of Altitude.
C V The parallaxis in Longitude.
V Q The parallaxis in latitude.
N O The ſpeere of the Sun.
L M The ſpeere of the Moone
T X The horizontall parallaxis of the ☽.
T H G Of the ⊙, A C B, the angle made. by the circle of Altitude and the Eclipticke. P the 90. degree of the Eclipticke.

Chapter 58.

Howe to finde when the Eclipſe of the Sun ſhall be.

Gemma Friſius 67.

FIrſt ſearch diligently when the time of the Suns Eclipſe ſhall be, which then in truth is, when as the Sun and the Moon are ſeene in one longitude. It hath byn already ſaide ingenerall if the coniunction of the lights happen between the aſcendent and the 90. degr. of the Eclipticke, that the viſible coniunction goeth before the true, as much as the parallexis in longit. commeth to: but if the place of coniunction be VVeſt from the 90. deg. then the viſible coniunction (that is the midſt of the eclipſe) ſhal follow the true coniunction according to the proportiō of the parallaxis in longitude. Therfore the time of the Eclipſe is gathered by the parallaxis in longitude. As in the example before, the parallaxis is found 39. min. in longitude, ſo much the moone doth exceede the Sun almoſt at the houre of the true coniunction. The queſtion is now, howe muche time it wil come too, while the moone is ouergoing the Sun this little ſpace. Therefore we muſt gather how muche the Sunne and how much the Moone doe goe in an houres ſpace, and howe much the motion of the Moone is greater then the Sunnes in an houre, and that according to ſight, if a man wil handle this matter curiouſly. The houre motion of the moone is thus had. The time of the true coniunction of the ⊙ and ☾ knowen by tables for that purpoſe, and the parallaxis in long. found by the laſt chap. if the coniunction be to come, adde one hour vnto the time of the true ☌: and again for that hour ſeek the altitudes & parallaxis of the

the ☉ and ☾ as before. Let the parallaxis of longitude be added to the true place, if the moone be Eastwards from the 90. deg. of the Eclipticke, but subduct it out of the true place, if the ☾ be VVastwards, and so shall you haue theyr *loca visa*, places seene. But if the true coniunction be past: which happeneth when the place of the true ☌, is in the oriental quarter: then subduct one houre, & seek the *loca vera* the true places of the ☉ & ☾, for that time, and their parallaxes in longitude and latitude. And againe, adde or substract the parallaxes of long. to or from the *loca vera* the true places of the lights, and so haue you their *loca visa* their places seen. The subduct the seene place of the time going before out of the seen place of the time following, so haue you the *motus visus* the motion seen: that is, how much the planet goeth forwards in the Ecliptick according to sight. But if you delight curious calculating, you must do this, as wel in the Sun as in the moon. And the you must take the Sunnes motion seene, out of the moones motion seene. So shall remaine the superation or exceeding of the moone aboue the Sunne in one houre according to sight. Now therefore by the proportion of the parallaxis in longitude vnto this houre superation you may gather the time betweene the true and seene coniunction or Eclipse: appointing the first number of the proportion, the houres outgoing or superation of the moone. The second one houre or 60. min. The third, the parallaxis in longitude. So shal come forth the min. of the time sought for, which being added too or substracted from the time of the true coniunction, sheweth the time of the Eclipse. These min. are added when as the place of the coniunction happeneth in the VVest quadrant of the Ecliptick, and are subducted in the East quarter. But this profitable institution must needes haue an example.

VVherfore, in the Eclipse hitherto intreated of the parallaxis of the moone in longitude, is found 39. min. These I adde because they are in the East quarter, vnto the true place of the moone, which is $7\frac{1}{2}$. of ♌, and so the place of the moone according to sight, which I call the place seene, or *locus visus*, shall be 8. deg. 9. mi. & 30. seconds in ♌. The parallaxis in longit. of the ☉ I will here omit for breuities sake, whereby the place of the Sun shall still remayne 7. deg. 30. in ♌, being both the true place and here allowed for the seene place. Nowe because it is most certaine that the middle of the Eclipse which as before sayd, is the visible coniunction, doth goe before the true, we are againe to get the true places of the ☉ and ☾, with their parallaxes for one houre before the true coniunction, that is, for 6. of the clocke 30. min. And then is the Sunnes true place 7. deg. 28. min. of ♌, the true place of the moone 6. deg. 56. min. of ♌: because the houre motion of the moone is 34. min. The Horoscope or ascendent for this tyme is 0. deg. 20. min. in ♍ the deg. of culmination 19. degr 30. min. of ♉, whose meridian altitude is 56. Further, the distance of the deg. of culmination from the horoscope is 100. deg. 50. min. of the Ecliptick, whereby the angle made betweene the horizon and the Ecliptick, is found to be 57. degrees 10. min. by the 51. Likewise the Sunnes altitude againe to bee 18. deg. $\frac{1}{2}$. and the moons altitude to be 18. deg. 20. mi. The angle of the Ecliptick with the circle of altitude is 53. almost by the 53. & this is the angle of latitude, therfore subducting that frō 90. there resteth 55. the angle of longit. of the moone. The parallaxis of the moone in her circle of altitude is found 52. min. almost by the 54. and in the sun 2. min. 30. seconds: therefore by the 55. the Sunnes parallaxis in longitude is almost 2. min. which beeing added to the true place of the Sunne, maketh for this houre the Sunnes place seene 7. deg. 30. min. of ♌. Lastly, the moones parallaxis in longitude is 42. min. and better, by the 55. Therefore her place seene, is by addyng those min. found to be 7. deg. 38. min. of ♌. Now therefore let vs take the place seene of the Sun going before, vz. 7. deg. 30. min. of ♌, out of the place following, vz. 7. 30. ♌, so there remaineth 0. This nowe is the Sunnes houre motion appearing or seene, which for want of paines commeth to nothing. In the like manner subduct the former motion of the moone appearing, vz. 6. deg. 56. of ♌ out of the later which were gathered to be 7. deg. 38. min. of ♌, and so is the houre motion of the moone founde to bee 42. min. For so muche shall the moone goe forwardes in one houre according to her motion appearing or seene. And because the Sunne maketh 0. his houre motion seene, and the moone 42. min. taking 0. out of 42. the moone shal ouergoe the Sunne 42. min. in an houre. The parallaxis of the moone in longitude at the time of the true coniunction was found 39. min. and of the sunne (if I had respected it) about 1. min. 20 seconds, but you must take this but as an example, and worke it exactly your selfe, therefore the moone had ouergone the Sunne then 38. min. 40. seconds according to sight. Last of all, because the moon doth ouergo the Sunne in an houre 42. min. she shall make 1. deg. 20. seconds (which is the difference of the Sunne and moones place seene at the time of the true coniunction) in 2. min. $\frac{6}{2}$. of an houre, with $\frac{6}{42}$. of a min. ouer. This time therefore because the coniunction seene, goeth before the true, we must take out of the time of the true coniunction, so shall remayne the time of the coniunction or Eclipse, appearing vnto vs. vz. 7. of the clocke and almost 28. min.

Chapter 59.

Another manner to finde out the parallaxis in longitude and latitude, as wel in the ☉ as the ☾.

Gemma Frisius. 68.

I Haue often times in this my booke spoken of Gemma Frisius Cursor and brachiolum, but perhappes euery man knoweth not what they are, the Cursor therefore is a rule, in length a semidiameter of the Instrumēt, and is so wrought with a rabbott or a doue tayle, as workemen call it, at one ende: that hee alwayes standeth square vpon the rule, and so slippeth vp and downe from one ende to another, his one side is deuided as halfe the rule, the other into an 100. or rather a 1000. equall parts, the brachiolum is a little arme at the end of the cursor, &c. This Chapter was to be performed by Sinicall working, and therefore impertinent to the *Iewel*.

Chapter 60.

To finde the latitude of the moone.

Gemma Frisius. 8.

THe Sun neuer digresseth from the Ecliptick, but the way of the moone lyeth by, as 5. degrees from the Ecliptick

cliptick, crossing him alwayes in 2. oppoſite points, of which the point Northwards is called *Caput draconis*, the other Southwards *Cauda draconis*. In theſe points only is the moone in the Ecliptick, and in or very neere them, the moone is at all Eclipſes, they haue a continuall motion contrary to ſignes ſequele, and perfourme it in 18. yeeres, and almoſt 5. monethes once round.

Therfore by tables or the Ephimeris, you muſt get the place of the moone for the time propoſed, and likewiſe the place of *Caput draconis*, if now the moone be departed from the *Caput* towards *Cauda*, the latitude ſhall be north: but from the tayle towardes the head, South. This knowen, reckon 5. deg. on the *Limbe* from the equinoctiall line, thereto lay the rule, then by ſubduction get the diſtaunce of the moone from one of knottes vz. *Caput drac.* or *Cauda dracon.* to which ſoeuer ſhe ſhall be neereſt, reckon this diſtance on the rule from the centre, and ſo the parallel cutting there, ſheweth the latitude ſought: this needeth no example.

Chapter 61.

How much of the Sunne ſhall be darkened.

Gemma Friſius 69.

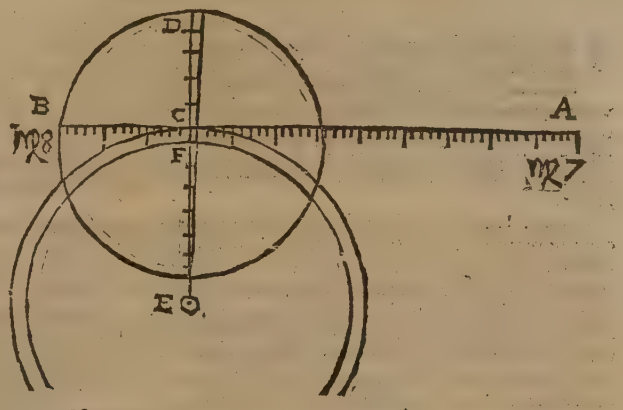
WHen as the Synode or coniunction of the lights happeneth neere one of the knots called *Caput* and *Cauda draconis*, then is there greate likelihood of an Eclipſe of the Sun to be. But it is a more certayne token if the place of the middle coniunction called *Synodus media*, happen leſſe then 20. deg. 40. min. before the *Cauda*, or after the *Cauda* leſſe then 11. deg. 20. min. Likewiſe if it happen before the *Caput* within the ſpace of 11. deg. 22. min. or after it within 20. deg. 40. min: then is it poſſible that the Sun may be eclypſed, without theſe boundes there can be no Eclipſe. But the moſt certaine token of all is, if the latitude ſeene of the moone doe exceede the quantity of both the ſemidiametres of the ſunne and moone ſeene, at the time of the Eclipſe ſeene, then ſhall the Sun ſuffer no Eclipſe. Of theſe things the whole inquiſition of the greateneſſe of the Eclipſe doth depend, vz. of the ſemidiametres of the lights, and the latitude ſeene at the time of the coniunction *viſa*, as well of the ☉ as the ☾. But as much as belongeth to the inuention of the ſemidiametres appertayneth not properly to this inſtrumẽt, but is gotten by their proper tables. And here generally it is inough to ſhew, that the ſemidiameter *viſus*, of the Sun neere his Apogeon, that is in ♋, is ſeene to be 15. min. & 49. ſeconds almoſt, for which you may take 16. min. in ſleight calculating, the ſunnes Semidiam. *viſus*, in the perigeon is 17. min. Therefore when as the greateſt differeth from the leaſt but one min. there is no cauſe to ſeek ouer curiouſly for the other places, althogh the *mutatio eccentrotetis*, maketh a litle diuerſity in this behalf, but being almoſt inſenſible, is here by me neglected. Now for the moones *Semidiametri apparentes*, the leaſt is 15. min. and the greateſt that may happen in the coniunctions 17. min. 49. ſeconds, which differ little from 18. min. Theſe therefore make ynough for our purpoſe.

For this take Gemma Friſius owne example, firſt mentioned in his 62. he recyteth of an Eclipſe of the Sun to be anno 1560. the 21. day of Auguſt, at one of the clock 22. mynutes after noon, by Stophers tables, the Sun and Moone then being 7. deg. 45. min. in ♍, the latytude at Louan beeing 51. degrees almoſt, where Gemma Friſius remayned. Nowe becauſe the ☉ in this Eclipſe is more neere his apogeon beyng ♋, then his perigion beeyng ♑, take for his Semyademetre ſixteene mynutes. The Moone is from hir Apogeon 5. *dodecatemoria*, that is 5. common ſignes and three degrees, and by that account beyng neere her perygeon, hath for her Semidiameter apparens 17. min. Theſe Semidiametres therefore gathered into one ſumme, make 33. mynutes: and if now the *Latitudo viſa* of the moone were greater then this Sunne, then as I ſayde before, there coulde be no Eclypſe. The *Latitudo viſa* of the moone is thus gotten. You muſt by the 55. gette the parallaxis in latitude for the time of the *Coniunctio viſa*: and likewiſe of the ſunne, if there be any. Alſo the latitude of the Moone for the ſame inſtaunt, calculated as in the laſt Chapter by her true place and diſtaunce from the neereſt knotte. If therefore this *Latitudo vera* be North, and the parallaxis of latitude leſſe then it, deduct this from the true latitude, and ſo remayneth her *Latitudo viſa* Northwardes: but if the parallaxis of Latitude, be greater then the North Latitude, ſubducting the North latitude out of the parallaxis of latitude, there ſhall be left the *Latitudo viſa* Southwardes. But if the *Latitudo vera* ſhall be South, adde the parallaxis of Latitude to the *Latitudo vera*, and ſo ſhall you haue the *Lititudo viſa* Southwardes. This therefore beyng gotten, you muſt take regarde alſo to the Sunnes paralaxis in Latitude, that is alwayes Southwards, becauſe the Sunne is alwayes in the Eclipticke, and all parallaxis happen downewardes. This therefore is all one wyth the parallaxis of Latitude. And it is alwayes added, when as the moones *Latitudo viſa* is Northwardes, and is ſubtracted in her South *Latitudo apparens*, vnleſſe the ſame be leſſe. For then it is taken from the *Latitudo viſa* of the Sunne, and ſo remayneth the moones latitude from the Sunne appearing to our ſight: which if you ſubduct from the number gathered of the Semidiametres of the ſun & moone, there ſhalbe left the part of the ſunnes diametre darkened: and multiplying that by 12. and deuyding the product by the ſunnes diametre, youſhal haue the poynts or dygites (as they cal them) of the Sunnes diametre darkened, as in this example the *Coniunctio apparens* or *viſa*. by the 56. is at one of the clocke and 16. minutes, the horoſcope 3. degrees in ♐. the angle of the horizon: and the Eclipticke 44. deg. and 45. mynutes by the 51. the angle of latitude 88. degr. almoſt by the 53. The altitude of the ſunne 44. degrees 42. minutes almoſt by the 31. whereby the paralaxis in latitude of the moone is 43. mynutes almoſt by the 55. So alſo the paralaxis of the ☉ in latitude is two minutes, the *Latitudo vera* of the moone is 23. mynutes Northwardes. Nowe becauſe the parallaxis of latytude is 43. minutes, and the *Latitudo vera* 23. minutes North, ſubduct it out of 43. there remayneth 20. minut. the moones *Latitudo viſa* Southwardes: but the Sunne alſo is ſeene diſtaunt from the Eclipticke 2. minutes *per aſpectum*. Therefore the Moone is ſeene more Southwardes then the Sunne eighteene mynutes: thys is the *Latitudo apparens* of the Moone from the Sunne, which ſubducted from the number gathered of the ſemydiametres gotten before to be 33. minutes, there are left 15. minutes for the part of the ſunnes diametre darkened.

Laſtly,

Laſtly, theſe 15. being multiplied by 12. digites of the diametre of the ſun, make 180. which deuided by the whole diametre of the ſunne, or by 30. there are produced 6. points or digites of the ſuns diametre, which is one halfe: ſome call them points or digites of the Eclipticke.

A The end of the 7. deg. of ♍.
B The end of the 8. deg. of ♍.
A B One deg. of the Eclipticke deuided into 60. min.
C The *locus viſus* of the Sun.
C F The *Latitudo viſa* of the Sunne
C E The *Latitudo apparens* of the Moone.
F E, The *Latitudo apparens* of the ☾ from the ☉.
F G, The part of the Suns dyamet. darkned diuided into digites.
E F, The Semidiameter of the ☾.

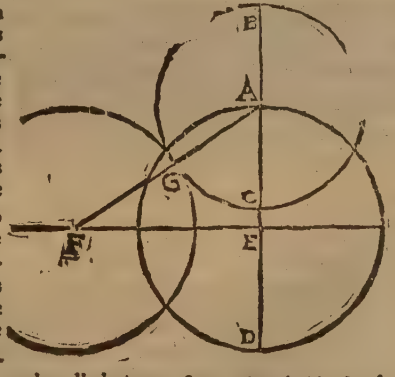


Chapter 62.

How long the Eclipſe of the ſunne ſhal endure.

Gemma Friſius 70.

MAke therefore a circle about the centre A, according to the bigneſſe of the Sunne, ſo that A B, bee 15. min. and the whole diameter B C, 30. min. and A E. The *Latitudo apparens* of the Moon from the ſun being in this laſt example 18. min. Therefore E is the *centrum apparens* of the moone. A D, the whole diametre of the moone, vpon the point E let there bee E F perpendicular: and then open the compaſſe according to the number gathered of the Sunne and moones diametres, which in the example before was 33. min. And ſo placing the one poynt of the compaſſe in the centre A, let the other touch the line E F in the poynt F. Now it is moſt euident that the Moone being in F, can couer no more of the ſunne, and that there is the end or beginning of the ſuns eclipſe. And when the moone ſhalbe in E, then is the middle of the eclipſe, which you may the eaſier beleeue, ſeeing G F is the Semidiameter of the ☾, the Sun and Moone both touching in G. Therefore E F is halfe the ſpace which the moone doth run in the whole Eclipſe of the Sunne: how much that is, you may get by our compaſſes onely on the ſcale or els multiplying A F into it ſelfe, and A E likewiſe, and then taking the ſquare of A E, out of the ſquare of A F, there ſhall be left by the laſt propoſitiõ ſaue one of *Euclides* 1. book, the ſquare of E F, whoſe roote is the quantity of the line E F. As in this example, A F is 33. min. the ſquare of this is, 1089. the line A E, being the *Latitudo apparens* of the Moone from the Sunne is 18. min. the ſquare hereof is 324. this taken out of the firſte ſquare, vz. 1089. There reſteth 765. the ſquare of the line E F, whoſe ſquare roote is about 27. min. ½. the quantity of the lyne E F. This ſpace of the *motus apparens* of the moon is reduced vnto time by the *motus horarius apparens* of the moone founde, as in the 56. which in this example wilbe 28. min. Now ſay by the rule of proportion 28. min. of the moones *motus viſa*, make one houre or 60. min. How much then ſhall 27. min. ½. and ſo following the rule, you ſhall finde 59. minutes, whiche are commonly called *minuta caſus* or *minuta incidentia*, that is to ſaye, howe muche it is from the beginning of the Eclipſe vnto the middeſt, and thence vnto the end whereby doubling theſe min. of incidence, you haue almoſt the time of the whole eclipſe, which here is two houres lacking 2. min. But yet I know well that theſe 2. times (that is from the beginning to the midſt, and thence to the end of the Eclipſe) are not alwaies equall vnleſſe the Eclipſe happen in the 90. deg. of the Eclipticke from the aſcendent, and that becauſe of the vnequality of the moones *motus apparens*, for the which in th orientall part the parallaxis of longit. is added to her true place, and is deducted in the occidentall.



He therefore that woulde performe this matter curiouſly ſhoulde as in the 56. get the *motus apparens* of the moone for one houre before the Eclipſe, and alſo for one houre after the middeſt of the Eclipſe, and thẽ meaſure the ſpace of the beginning of the eclipſe vnto the middle called *ſpacium incidentiæ*, by the *motus horarius*, going before, and the ſpace between the middeſt, and the end of the Eclipſe called *redditus luminis* by the houre motion of the houre following. And thus haue you all the reaſon hereof, although perhaps I haue not beene curious in the examples, ſince I haue ſet downe the inſtruction ſo plaine.

Blagraue. Note that I haue ſet downe theſe tearmes *motus viſa*, *Latit. viſa*, and ſuch like in Latine words, leaſt any man ſhould in Engliſh ſenſe ouerſlip them as words of courſe, being indeed words of art, and ſuch as this matter dependeth on,

Chap

Chapter 63.

Of the Eclipſe of the moone, the greatneſſe and duration of the ſame.

Gemma Friſius 71.

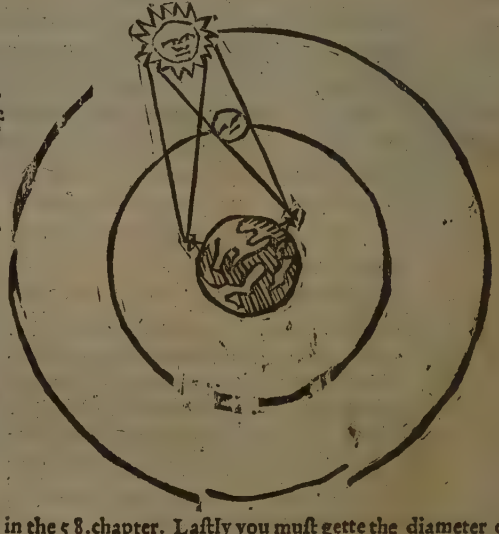
THe Eclipſe of the moone hath an eaſie calculation, the cauſe whereof is, that it dependeth not vppon the difference of ſeeing it in any reſpect (as before in the ſunne.) For as oft as there happeneth an Eclipſe of the moone, becauſe that ſhe beyng oppoſite to the Sunne, lighteth into the ſhadow of the earth, which extendeth it ſelfe farre beyond the ſpeere of the moone, and taketh away the light which ſhe had of the Sunne: ſhe by this meanes eclipſeth in like bigneſſe and manner to all places of the world: and continueth like time, and is ſeene euery where at one moment, although that it be accounted at diuers houres in dyuers places, according to the diſtaunce and difference of the meridians, as hereafter I will ſhew in the longitude of places.

Blagraue. It appeareth here that Gemma Friſius had a meaning to intreate of the longitude of places whiche Oh would God he had liued to haue performed, that it might haue beene my good happe to haue ſeen his vttermoſt, in that behalfe, by which meanes I ſhould haue eyther ſpared altogether the greate endeuour which I of neceſſitie muſt now for the credites ſake of my Iewell employ in that behalfe, or at the leaſt haue receyued ſuch light from his doynges, that I might with eaſe haue gone through, with it. But now Gemma Friſius is gone, lamenting will not helpe: he left his ſonne Cornel. Gemma behynde, who publiſhed his Fathers woorke of the Catholicon, and ſtryued to augment it by his owne induſtrye: but God knowes, againſt the ſtreame. For a man may eaſily knowe by the very matter and manner of it, his doyngs (of whiche I haue omitted the moſt part) from his fathers.

Gemma Friſius.

But now to come againe to the matter, as the Eclipſe of the moone is vniuerſall at one inſtaunt, it is farre otherwiſe in the Sunne: for one ſelfe ſame Eclipſe of the Sunne to ſome appeareth great, and laſting: to other ſome little and gone in a moment: to ſome the North part, to ſome the South part of the Sunne is ſeene to be darkened: and that in infinit diuerſities. The cauſe of ſo great variety, is the diuerſity of the places whence the ſun is beholde: bicauſe that in the eclipſe of the Sunne he looſeth not his light, as the common ſort do imagine: but only that the moone commeth betweene vs and the ſun. VVhereby all countries ſee not the Eclipſe in one maner. Inſomuch that ſome doe ſee the ſunne in his ful light, when that others ſee him almoſt wholly eclipſed. For the ſeeing of it, according to the ſcituation in ſundrye places, is the greateſt cauſe of the diuerſity of the Eclipſe of the ſunne. But in the Eclipſe of the moone, the view euery where doth vary it nothing, neyther in lõgitude nor latitude, for the moone is darkened indeede, where there the ſun is not (as it already ſaid:) and therfore are we forced to ſeek ſo many variations of aſpect in the ſunne which in the moone needeth not. It ſhalbe ſufficient here to take the time of the true oppoſition of the ſun and moone for your meridian, either out of their proper tables, or out of Ephimerides, rightly calculated: & for that time to get the true place of the ſun in the ecliptick, whoſe oppoſite is the iuſt place of the moon: & then ſeek the latit. of the mooue very diligently, as is ſhewed in the 58. chapter. Laſtly you muſt gette the diameter or ſemidiameter of the moone: and likewiſe the ſemidiameter of the ſhadowe of the earth, of what quantity it is in the place of the moones paſſage. The ſame is ſomtime greater, ſomtime leſſe, for two cauſes: for when the ☾ is neere her perig. ſhe findeth the ſhade of the earth greater then in other places: the ſhadow of the earth runneth out taperwiſe vnto a point at the laſt, & becommeth leſſer by ſo much the further as it extendeth frõ the earth. Secondly, the ſhadow of the earth may be greater in the ſelfſame place of the moons paſſage, by reaſon of the diſtance of the ſun from the earth. For the neerer the ſun commeth toward the centre of the earth, ſo much the ſhadow of the earth groweth the narrower & ſhorter, contrary wiſe, by the ſunnes bearing backe from the Earth, it is extended and enlarged in the ſame place of the ſpeere of the moone, in which it was narrower before, as by theſe figures you may ſee.

The Sunne eclipſed.

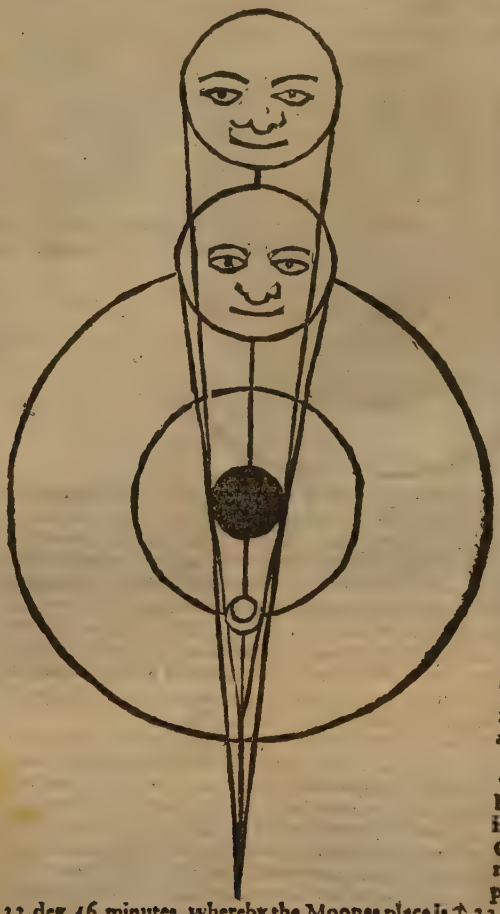


Therfore to our purpoſe you muſt know by tables the time of the true oppoſition of the ſun & the moone in the Eclipſe: and the place of the ſun & the moon for the ſame time, together with the latitude of the moon. And then the ſemidiameter of the moon, & of the ſhadow, through which the moons paſſage is. And here wil I ſhew in brief as much as ſhal ſuffice the learner to get the ſemidiamet. of the ſun, the moon, & of the ſhade by the *motus horarii*, or diurnall motions of the Sunne and the moone. It is found out by the induſtry of artificial men, that what proportion 20. beareth to 11. the ſame doth the ſuns diurnal motion vnto his diamet. appering. Therfore multiply the ſuns diurnal motiõ gottẽ out of any tables into 11. & deuide the product by 20. ſo haue you the diam. of the ſun. The cauſe is, for that both the greatnes of the diamet. *apparens* of the ☉, & ☽ ſwiftnes of the ſuns motiõ are increaſed & diminiſhed in like proportion, according to ☽ fite of the ☉ in his excentricke.

Diameter of the Sunne.

The

The sunne in his Apogeon or farthest distance from the earth.



The sun in his perigion or neareſt to the earth.

The figure of the Eclipſe of the Moone.

The diametres alſo of the Moone do likewiſe keepe a proportion with her motion, ſo that the diametre *Apparent* of the Moone is almoſt equall to her *Motus Horarius*: Purbacchius ſaith, what proportion 48. beareth vnto 47. the ſame hath the *mot. horarius* of the moone vnto her *Diameter apparens*: therefore if a man take the *motus horarius*, or houre motion of ☽ for her diametre, he ſhal not miſſe a minute. But to haue it exactly, multiply the *motus horarius* of the Moone into 47. & deuide the product by 48. & therof ſhal come the moones diametre. Laſtly the diametre of the ſhadow of the earth you ſhal thus get. Multiplie the diametre of the moone founde as before into 13. the product deuide by 5. and ſo ſhall you haue the greateſt quantitie of the ſhadowe in that paſſage of the Moone, that is to ſay, the ſunne being in the Apogeon: but the ſunne being in other places, the ſhadow abateth in the ſame conſtitution of the ☽, as is ſaid, by ſo much the more as the ſun commeth neare to the earth: and how much the diametre of the ſhade is in another place, that is found by the *motus horarius* of the ſunne, for by how much greater it waxeth in other places, the ſhade of the earth is made leſſe, by ſo much ten times told: Theſe rules are both generall, exact, & moſt excellent, which by a familiar example I will manifeſt.

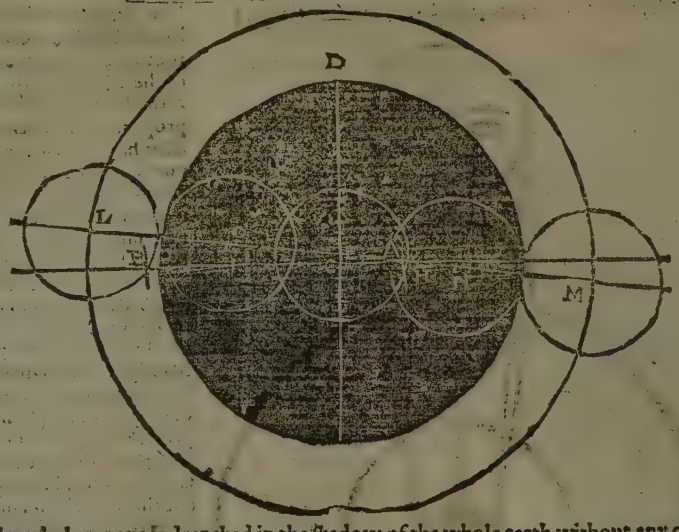
Diameter of the moone.

Diameter of the ſhad of the earthe

In the yeare 1555. the 4. of Iune the 14. houre, and 42. min. there is like to be a great eclipſe of the Moone, which is to be knowne in that the place of the ☽, at the time of the true oppoſition is not farre from *Cauda Draconis*. For the place of the ſunne is according to common tables ♈ 22. deg. 46. minutes, whereby the Moones place is ♎ 22. 46. alſo the *Caput Draconis* is in ♈ 23. deg. 8. minutes, therefore *Cauda* is in ♎ 23. 8. ſo that the true place of the Moone is but 21. minutes from *Cauda Draconis*, wherby there is not onely knowne that an Eclipſe ſhall be, but alſo a verie great one: for as oft as the Moone is aboue one deg. 8. min. in latitude any way, then ſhall the Moone auoide the ſhadow in her race. But heere the latitude of the Moone is ſcarce two min. which is a token that the Moone ſhalbe verie neere the centre of the ſhadow of the earth in this Eclipſe. Now to know the quantitie & continuance of the ſame, we muſt know the ſemidiametre of the Moone, & of the ſhade of the earth by the rules before ſhewed. The *Motus Diurnus* of the ☽ in that place is 13. deg. 5. therefore her *Motus horarius* ſhalbe 32. min. 40. ſec. and ſomwhat leſſe: then this ſhalbe the diametre of the moone: but if you wil know it exquiſitly, multiply 32. min. 40. ſec. by 47. & deuide the product by 48. & ſo ſhal you haue 32. min. 20. ſec. almoſt, & the ſame is the iuſt diametre of the Moone: halfe that vz. 16. min. 10. ſec. is her ſemidiameter: which multiplie by 13. and the product deuide by fiue, you haue the diametre of the ſhade of the earth in the place of the Moones paſſage in her ſphere, the ſun being in his apogeon, the multiplication of the diametre maketh 25220. ſec. the diuiſion produceth 5044. ſec. that is 84. min. 4. ſec. ſo that the ſemid. of the ſhade is 42. min. 2. ſec. And becauſe the ſun is neare his apogeon, the ſhadow of the earth cannot be diminiſhed any quantity, to be accounted of by reaſon of the ſuns comming neare vnto the earth, otherwiſe you ſhould heere ſeeke the *motus horarius* of the ☉ being in his apogeon and alſo for the place where he now is, and the difference of theſe motions decuplied, that is multiplied by 10. ſhould be taken from the greatneſſe of the ſhade here found, & ſo ſhall you haue the exquiſite bigneſſe of the ſhade of the earth, but here for methodes ſake we thinke not good to proſecute euery leaſt matter, but leaue ſuch curioſitie to thoſe that haue more leiſure, or who are whollie addicted to theſe ſtudies. By theſe things found, you may onely by drawing a figure knowe the greatnes and duration of the eclipſe, draw therefore the ſtreight line A B. which ſhall be the 22. deg. of ♎ deuided into 60. min. Then in the 46. min. in which ſhall be the centre of the ſhadow of the earth, that is to ſay, oppoſite to the ☉ at the time of the true oppoſition, place the one foote of your compaſſe, and there according to the quantitie of the ſemidiametre of the earth now founde videlizet 42. minutes, make a circle for the ſhadow of the earth, the centre being C, whereon draw the line D E perpendiculer to A B, which is the circle of the latitude of the Moone, and becauſe the latitude of the ☽ is found 2. min. northwards, take in your compas 2. of the 60. parts of A B, & place the ſame from C. towards D in the point E. & that is the centre of the Moone: in this centre according to the ſemidiametre of the ☽ vz. 16. min. 10. ſec. make the circle of the moone, which being done you ſhal ſtreight ſee before

the moone auoideth the ſhadowe of the earth.

facit 1 11 111
32. 42. 30.
31. 59. 10.



your eyes that the whole moone is drenched in the ſhadow of the whole earth without any calculation. And if you deuide the whole diametre of the moone into 12. digits, you ſhall apparantly ſee how many digits or points the clipſe of the moone ſhall be. For looke how many digits of the moones diametre D F. ſhall containe (with the diſtance from the vttermoſt ſhade of the earth vnto the edge of the moone fartheſt drenched within the darkneſſe) ſo many digits or points as they now call them ſhall the clipſe be ſaid to be. For D is the point of the ſhadow of the earth, moſt bending from the clipticke towards the which the moone departeth, but by numbers we ſhall thus proceed. Becauſe E F is 16. min. & 10. ſec. and the latit. of the Moone E C. 2. min. therfore C F ſhalbe 14. min. 10. ſec. to which there being added C D, being 42. min. 2. ſec. the whole D F ſhal be 56. min. 12. ſec. Now by the rule of proportion, if 16. min. 10. ſec be worth 6. digits, what ſhall 56. min. 12. ſec. be worth: & ſo following on the rule, you ſhal get 19. digits & 41. min. of a digit ſuch as the whole diametre of the moone maketh 12. To be ſhort the whole moone containing 12. dig. ſhalbe wholly drenched in the ſhadow: & that ſo deepely that the ſhadow ſhal exceed the moone 8. dig. almoſt, which is as much to ſay, as that the clipſe of the moone ſhalbe almoſt 20. digits. The moone her ſelfe conteineth not aboue 12. points, but the depth of the moone within the ſhadow of the earth ſhalbe almoſt 20. dig. wherby you ſhal vnderſtād that when as the greatnes of the clipſe exceedeth 12. digits, then ſhal there be an eclipſe with tarriance, as they call it, that is, the moone ſhal tary a certaine ſpace in the darknes before ſhe ſhal receiue her light againe of the ſunne: & how many the more digits there ſhalbe found, by ſo much the longer ſhall the tariance of the moone be in the darkneſſe, & the whole eclipſe endure: both which exactly to deſcrie, thus muſt you do. Open your compaſſe to the quantitie of the ſemidiam. of the earth and the ☾ ioyned togither as in this example, vnto 58. min. 12. ſec. and on the centre of the ſhadow of the earth vz. C, deſcribe a hidden or blind circle, and note wel the touching of this circle with the way of the Moone. I cal the way of the moone a line drawne by the centre of the moone vz. E, parallel if you liſt to the line A B. or if you be diſpoſed to proſecute theſe matters more narrowly: let this line make with D F the blunt angle D E M. of 95. deg. as heere the line L E H M. is, for this is the true way of the Moone whereby H is the place of the next knot. This line is cut of the blind circle in the points L & M, in which points the Moone being, maketh the beginning and end of the clipſe. Laſtly, from the 2. interſections of the ſhadow of the earth, and the way of the moone, ſet the ſemid. of the moone by helpe of your compaſſe in the way of the Moone vz. in N and O. For in the one of theſe places the Moone is altogether entred into the ſhadow of the earth and in the other, beginneth to get out thereof. Therefore you haue 5. moones if you liſt, the firſt on the centre L. where the ☾ begins to eclipſe: the next on the centre O, when ſhe is wholly darkned: the third on the centre E, when ſhe is in the middle of the clipſe, the fourth on the centre N. when ſhe beginneth to get light againe: the laſt on M. where the clipſe endeth, ſo that L O is the ſpace, that the moone goeth from the beginning vntill ſhe be all darkned, and O N of her whole darkning, which they call the tariance in Latin *Mora*: therefore O E is halfe her tariance called (*Dimidia mora.*) All which parts you may meaſure with your compaſſe by the parts of the clipticke before made: and deuiding ech of them by the *Superatio horaria* of the moone you ſhall haue all the times ſought for, or the whole taken togither vz. L M. And by numbers may thus be performed. For that E C is 2. min. in latitude, and ſtandeth almoſt perpendiculer on L M. the way of the ☾, therfore the ſquare of L C ſhal be equal to the ſquares of L E, and E C. therfore taking the ſquare of E C out of the ſquare of L C, there ſhal remaine the ſquare of L E by the laſt propoſition ſauing one, of the firſt booke of Euclide: For L C is the ſum gathered of the ſemidiametres of the moone, and the ſhade vz. 58. minutes, 12. ſeconds, but letting paſſe the ſeconds, the ſquare of L C ſhall be equall to 3364. herehence taking the ſquare of C E, vz. 4. there is left 3360. the ſquare of L E, whoſe ſide is ſomwhat leſſe then 58. and that is the line L E, ſo much alſo is E M. Let no man carpe heere becauſe we ſaide that C E was perpendicular to the Moones way, when as before we drew him perpendiculer to the clipticke, the beſt learned men will neglect ſo much, becauſe it bringeth no perceiueable error. Therefore the line L E being knowne to bee fiue 58. minutes almoſt, take out of that the ſemidiametre of the Moone vz. 16. minutes 12. ſeconds, the line L O ſhalbe 41. min. 48. almoſt, which they call *minuta incidentia*, and N M is almoſt equal vnto it, called *minuta repletionis*. Laſtly ſubduct L O being the minuts of the clipſe waxing out of L E, there ſhal be left O E halfe the tarriance vz. 17. min. 12. ſeconds almoſt. Now becauſe the *Motus horarius* of the Moone

was

was 32.min. 40. seconds, and the sunnes *Motus horarius* 2.min. 22. sec. take the one out of the other there resteth 30.min. 18.sec. the superation of the moones gate aboue the sunne in one houre. By this deuide all the parts of the Moones way before founde and you shall haue the tymes correspondent vnto them. As because the Mynuts of the waxing of the Eclips were 41. mynuts 48.so deuide those by 30.mynuts 18.seconds by reducing each number vnto secondes,so shal amount one howre 22.mynuts,the time of the waxing and likewise of the wearing of theclips. Likewise deuide the minuts of *Dimedia mora* vz. 17.my.12.by 30.min.18. seconds there commeth 33.my.of an howre,wherby the whole darckning is 1.howre 6.my. the whole time of the Eclips 3.howres 50. mynutes.

Chapter 64.

How to get the parallaxis of the ☾ Moone out of the heauens at any houre proposed, the latitude knowne with the longitude and latitude of the ☾.

Gemma Frisius 72.

THe Moones place giuen at any instant proposed, calculate hir altitude on the *Iewel* by the 32. take the same instant the altitude of the Moone, by obseruation, if these two agree there is no paralaxis, which can neuer bee except the Moone be neere the zenith, the difference of these two is the paralaxis, but this requireth exact calculation and obseruation.

Chapter 65

To know the greatest, or horizontall parallaxis of the Moone when she is to be seene.

Gemma Frisius 73.

GEt the paralaxis of the ☽ for the altitude she is in at the instant proposed, then reckon the same altitude on the rule of the Iewell inwardes, and then moue to and fro till that poynt of the Rule doe cut the paralell answering the paralaxis of altitude, and so doth the *Finitor* shew in the *Limbe* the horizontall paralaxis sought for. In this dooing you may accompt euery degree of the paralels for 10.mynuts.as in the 54. and 55. Cap. The greatest horozontall paralaxis is the ☾ being most in her perigeon 63. mynutes almost. Hereof shall I treat at large in my worke of Longitudes.

Chapter 66.

The Longitude and Latitude of two Starres giuen, how to know the distance betweene them.

Gemma Frisius. 74.

BY this Chap.and others following is shewed to find the distance of starr, & also of townes, cities, & places as easily,and redily as on the globe it selfe, which no doubt must needs make the instrument very delectable. The longit.and latit. of any two starr had,subtract the greater long. out of the lesse, so haue you the difference,which being had,number in the *Limbe* from thequinoctial the greatest latitude of the two starr southwards,if the latit. be south,or northwatds,if north: and thereto lay the ζenith point of the *Reete*,then in the meridian reckoned from the *Limbe* answerable to the difference of longit.number the lat.of the other starr and that from thequinoctiall accordingly,and the azimuth cutting there,sheweth the distance sought for, if you reckon thereon thence to the zenith point.

Example. I would know how many degrees *Canis maior* is from *Oculus tauri* I finde by Stophler (for any tables will serue the turne, as well old as new for that their difference of long. and their latit. neuer alter) that the longit. of *Oculus tauri* was then in ♊ $2\frac{18}{60}$ deg. that is from o.in ♈ $62\frac{18}{60}$ deg. and his latitude,5.deg.$\frac{10}{60}$ southwards. Likewise *Canis maior* in ♋ $7\frac{18}{60}$ which commeth to $97\frac{18}{60}$ deg.from ♈, and his latit. to be $36\frac{10}{60}$ southwards also. Now subducting the lesse longit.vz.$62\frac{18}{60}$ out of the greater vz.$97\frac{18}{60}$ there resteth 35.the difference of longitude. Firste therefore I reckon in the *Limbe* from thequinoct.line, the greatest latit. of these vz.$39\frac{10}{60}$ towards the south pole,because the latitude is south,and thereto I set the zenith of my *Reete* then in the 35. meridian counted from the *Limbe*, I reckon the lesser latitude from thequin. line vz. $5\frac{10}{60}$ deg. southwards,also because that lat. was likewise south: this done,I see the $52\frac{1}{4}$ azimuth to cut the place of the second starre whose deg. betweene the same place and the zenith by helpe of the almicantaries, I finde to bee $46\frac{1}{4}$ therfore I boldly pronounce that the distance betweene *Oculus tauri* and *Canus maior* is $46\frac{1}{4}$ degrees.

Chapter 67.

How the distance of any two starres vnknowne may be had.

Gemma Frisius. 75.

THis may you do by the 38. Chap. getting their longit.and latit. out of the heauens, & then proceeding by the last Chap But yet an easier way without al that circumstance is thus: take the altitude and azimuthes of both starres at one instant, or at the least the distance of their azimuthes without respect of the meridian: these had the working is all one with the last Chapt.but onely chaunging the names, the difference of their azimuthes, for the difference of longitude: and their altitudes for their latitudes, and where as the equinoctiall did in the last Chapter represent the Eclipticke, hee must heere represent the horizon and the parallels, circles of altitude, &c. This needeth no example, for if you will suppose the altitudes

of two ſtarres equall with the latitudes in the laſt Chapt. and the diſtance of their azimuthes equall to the difference of longitude there, the matter is already performed.

Chapter 68.

To know how long the taile of a Comet is.

Gemma Friſius 76.

VVOrke altogither as in the laſt Chapt. with the head and laſt point of the taile of the Comet, as though they were two ſeuerall ſtarres and the diſtance found is your deſire.

Chapter 69.

Another way to ſerch the diſtances of ſtarres one from another.

Gemma Friſius. 78.

GEt their declination by the 7. Chapt. and their difference of right aſcenſion by the 17. or 38. or by obſeruation, theſe had, worke altogither as in the 64. Chapt. onely chaunging the names, as is ſaid in the 65.

And thus haue you diuerſe and excellent wayes to examine the diſtance of ſtarres.

Blagraue. Truely theſe are very prettie concluſions & pleaſant, but yet not ſufficient to correct and amend the places of fixed ſtarres and planets, and the whole globe, as G. F. affirmeth, except they be performed by a very huge inſtrument at the leaſt of 10. foote diametre. But the onely way inſtrumentally to performe theſe things in my opinion (*Saluo meliori iudicio*) is by their croſſe ſtaffe to take their diſtances, and thereby to rectifie their places of longitude and latitude, vpon a great quadrant, as I will ſhewe you hereafter in my booke of logitudes if God giue me leaue and leiſure once to come to it, to the which no doubt theſe Chapters are good preambles and introductions, notwithſtanding for thoſe that take delight in varieties, I will ſomwhat helpe to fit their fancies. If you would know the diſtance of any two ſtarres placed in my *Reete*, turne it about till ſome one meridian touch the apex or point of either ſtar, and the degrees of the ſame meridian included betweene them, numbred by helpe of the parallels ſheweth your deſire, but then you muſt be ſure that theſe ſtarres be both North, or both South, declining from the equinoctiall. In my *Reete* I appointed all the North ſtarres to point outwards from the centre, and the South inwards.

Example. Oculus tauri, & *Canis minor* are north ſtars, and in my *Reete* their apex pointeth outward, turne the *Reete* about & at laſt you ſhal find the $17\frac{1}{3}$ meridian to touch both their apex & the diſtance betweene them on the ſame meridian $46\frac{1}{2}$ deg. But if one ſtar be North & the other South, yet wil I wiſh you wel: then turne about the *Reete* vntill the apex or points of either ſtarre do touch ech a ſeueral meridian, but equally taken on ech ſide of the axtreeline, and then muſt you reckon from the one of them to the pole, and from the pole backe againe to the other, and ſo haue you your deſire.

Example. Of *Oculus tauri* & *Canis maior*, the one in my *Reete* pointeth outwards, the other inwards, wherfore I turne the *Reete* till at the laſt I finde *Oculus tauri* to cut the 46. meridian on the left ſide of the axtreeline, and *Canis maior* the 46. meridian on the right ſide of the axtree, where I finde from *Oculus tauri* to the pole $23\frac{1}{4}$ deg. and from the pole to *Canis maior* $23\frac{1}{2}$ deg. theſe put togither make $46\frac{1}{4}$ deg. the diſtance of theſe two ſtarres.

Chapter 70.

The longitude and latitude of two ſtarres giuen, to get the angle of ſtation of one from another.

Gemma Friſius 80.

The angle of ſtation.

THe angle of ſtation is the diſtance of the azimuth, wherein any ſtarre is from the meridian of ſome called the angle of poſition. Place therefore the two ſtarres giuen according to their difference, longitude and latitude giuen in all reſpectes, as in the 64. Chapt. and the very ſame azimuth that there ſheweth their diſtance, ſheweth alſo the angle of ſtation, of one of them from another, being counted from the *Limbe*, and therefore I neede ſet no other example, but looke in my booke following of Coſmographie, and you ſhal perceiue it plaine, the like may you performe by their difference of aſcenſion and declination, or their altitude and difference of azimuthes.

Chapter 71.

To know whither three ſtarres or cities be in one great circle.

Gemma Friſius. 81.

THis Chapter is verie pleaſant and no leſſe profitable in amending the places of the fixed ſtarres in the globe celeſtiall. Firſt therefore gette the angles of ſtation by the laſt Chapt. of one of the ſtarres from ech of the other, and if theſe angles be equall then are they in one great circle, elſe not.

Blagraue. This Chapt. of Gemma Friſius is true, ſo that you get the angles of poſition of the middlemoſt ſtarre, and of one of the other from the third, but if you get the angles of poſition of the other two from the middlemoſt, then if the angles of poſition being equall do make one ſtreight line, that is to ſay, if the one be Northeaſt, then if the other be Southweſt or ſo forth, you haue your deſire, euen like as in the compaſſe any two oppoſite points make one ſtreight line.

Chapter

Chapter 72.

That the taile of a Comet extendeth it ſelfe directly from the Sunne, and howe you may try it.

Gemma Frisius 82.

THE Philoſophers affirme that a Comet is ingendered of a ſoft clammie ſlime, or viſcous ſubſtance, apt to nouriſhe fire drawen vp into the higher moſte region of the ayre, and there is ſet on fire, by the firy element, to whiche he is very neer: & that his taile cōmeth of the flowing or dragging of ꝑ matter, like as in ſtarres that ſhoote, where the matter of exhalation is, by his ſhutting drawen in length. But as conterning the tayle, that cannot bee ſo, both becauſe his motion is verye ſlowe, and alſō for that it hath alwayes been obſerued of learned men, as namely, Apian and others, that the tayle of euery Comet extendeth it ſelfe directly from the Sunne, ſo that the Comet his taile, and the Sun are in one great circle, as at all times by the laſt chapter, you may proue when any Comet happeneth.

Cornelius Gemma. It hath pleaſed God, as it ſhould ſeeme, to take away Gemma Frisius, when he hadde perfourmed thus farre, and before he had furniſhed this chapter, whiche his ſonne Cornelius G. took in hand to accōpliſh & proſecute the ſame very tediouſly, to little purpoſe, as hee doth all the propoſitions & chapters afterwards, which I mean to abreuiate in as much as ſhalbe neceſſary, & the rather becauſe I ſhall ſtuffe out this worke with ſuch ſtore of matter, that there will be no place for ſuperfluities. Hee taketh occaſion here vtterly to condemne all the Philoſophers, who ſay that there is a firie region or element next aboue the ayre, affirming that all fire and heate remayneth in the Sun. And further, that Comets are ſet on fire by the Sunne only: his greateſt reaſon is, for that if the comet were ſet on fire by force of the firy element, then muſt of neceſſitie his taile bee rounde about alike, but becauſe the tayle is alwayes found directly from the Sunne, therefore it is manifeſt, that the Sunne is the only cauſer of his flamme, appoint the Sunne, the Comet and his taile, inſteede of the three ſtarres in the laſt chapter, and the working is all one, if you liſt to make experience thereof.

Cornelius Gemma

Chapter 73.

To knowe what point of the heauen is in the Meridian of any place at any inſtaunt propoſed, and what it is a clocke in any other countrie.

Cornelius Gemma 85.

PLace the degree of the Sunne to the houre propoſed in the *limbe* by the help of the rule then number in the *Limbe*, from the noone line, the difference of longitude of that countrie from yours Eaſtwardes, if it lye Eaſtwardes, or VVeſtwardes, if otherwiſe: and thereto lay the rule, and it ſheweth the degree of the Zodiacke, or any ſtarre lying in the ſame meridian. Nowe if you turne about the *reete* til the degree of culmination of the inſtant propoſed lye vnder the rule, and then remoue againe the rule too the houre propoſed, marking what degree of the Zodiacke he there cutteth, laſtly, remouing the rule and the *reete* together, being ſtill on this laſt degree, vntill the degree of culmination come againe to the noone line, it ſheweth then in the *Limbe* the houre of the other countrie ſought for.

Example.

The Sunne being in ♉ 1. degree, I woulde knowe at ten of the clocke in the morning, what degree of the Zodiacke is the meridian at Rome: and what of the clocke it is there, whiche to doe, I number the difference of the longitude of Rome from vs, vz. 23. degrees, and that Eaſtwardes from the noone line, becauſe Rome lyeth Eaſtwardes, which I knowe, becauſe his longitude is more then ours: whereto I lay the rule, which ſheweth in the Zodiacke ♈ 23. degrees 45. the ſame degree is then in the meridian at Rome, and euery ſtarre or point els hauing that degree his mediation: which knowen, bryng the degree of culmination which then is ♓, 29 degrees vnto the ſame difference of longitude, and then turne the rule againe too the houre propoſed, vz. ten of the clocke, there ſhall you finde the 6. $\frac{2}{3}$. degrees of Aries. Nowe turne about the rule and the *reete* together, vntill the degree of culmination, vz. ♓ 29. come againe into the noone line, and ſo doth the rule ſhewe 11. of the clocke, and 9. degrees paſt, whereby I conclude, that it is 11. of the clock, & 9. degrees paſt at Rome, when it is but 10. at London.

Blagrave. The ſame may you doe another way, if the *limbe*, or vttermoſt Azimuth of the *Reete* were deuided into 12. equall partes or houres, the Zeneth point being twelue, at noone, & his Nadir 12. at night, and then placing the Zeneth point on the difference of longitude, the rule laide on the *limbe* of the *Mater* to any houre ſheweth in the *limbe* of the *reete* among theſe newe houres, the houre of the other countrie.

Chapter 74.

How to direct a ſhip by the ſtarres in any voyage.

Cornelius Gemma 86.

VVHen you ſet foorth from the ſhore, ſet the degree of the Sun vnto the ſame houre or inſtaunt, and thence turne the rule vnto the difference of longitude, as in the laſt chapter, of the place you meane to ſayle vnto: then numbering on the rule from the *limbe* inwardes, the latitude of the ſame place you goe to, there is the Zenith of the ſame. Nowe if there chaunce any ſtarre to be in this Zeneth, direct your ſhip full vpon him, & you ſhall goe as certainly, as if Mercurius were your guide. But if the ſtarre be in the ſame meridian but not in the zenith, reckon howe many degrees on the rule hee is diſtaunt

from thence,and according too that distaunce, imagine a point in the heauens,so muche declining from the same star in a circle likewise imagined,from the pole to the same star,and direct your ship therto, as neere as you can,this experience must you make from time too time, still seeking what starres come vnto the zenith or meridian of the place you goe vnto.Thus much for sayling by night.But in the day time by the altitude of the Sun,you must still seeke the latitude you are in,and the same shall direct you by a parallel vnto the equinoctiall,til you haue sayled as much as the difference of longitude cometh to,& then you being vnder the meridian of the place desired,direct the ship ful North,or South, as the latitude requireth vntill you reache your hauen.

Blagraue. This course of sayling by the starres is very certain, if the starre bee in the Zenith of the place you sayle to,or verie neere,but to imagine where the point of the Zenith is,by the starres distance from him, cannot easily be performed with certaintie,so the starre may be placed.But in my booke of nauigation,I will prouide you a conuenient remedie: as for his sayling by the Sunne, it is too bad, and there you shall also finde where I will make it easier.

Chapter 75.

To make an horrizontall and South wall diall by the Iewell.

Cornelius Gemma 92.93.

PLace the *finitor* to the latitude,and reckon what degrees of the meridians are comprehended betweene euery 15 deg.of the *finitor*,the same serue for the deg.betwene euery houre space in your diall,but neere the center of the *Iewel* representeth 12.of the clocke,& the *Limbe* 6.of the clocke contrary too the whole woorking in my booke of dials, and contrary to the foundation whence all dials are deducted, as I may speake it: but yet as true as the other.For whether you take the deg.of the *finitor*,between euery 15.meridian,or the number of meridians between euery 15.deg.of the *finitor*,all commeth to one passe,but that in the one 12.of the clocke is in the center of the *Iewel*,in the other at the *Limbe*.Reade my booke of dials,and you shall not be to seeke of this that is here said. But now as touching the South wall diall, there is no difference from that in my booke of dials,whereto you may resort.

Chapter 76.

To finde the declination of any wall from the South,and fitting a Diall thereto.

Cornelius Gemma 94.

MAke a perpendiculer on the wall,and in him sticke a stile or pin plum from the wall,then tarry vntill the shadow of the stile be directly on the perpendiculer, the same instant take the altitude of the Sun and thereby get his azimuth,for the deg.of the azimuth frō the South shall bee the declination sought for:nowe hauing the declination,make a South wall diall, and boulster him out from the wall,so many degrees as the declination commeth to,and there let him stand.

Blagraue. First,Corn Gem.here sheweth to take the declination of a wall from the South,but for North declining walles wee are neuer the neere, neyther are they too bee doone heereby but onely in the Sommer time when as the Sun is in the North signes,& yet then not half of them.Besides that in walles that decline not much from the South,this way is very vncertaine, because too those it is almost noone ere the stile giue his shadow on the plum line, and then is the azimuth scant truly to be gotten by the altitude, except it be taken by an huge instrument: but in my booke of dyals,I haue prouided for all these, where I haue also found to make dials to any wall or flat whatsoeuer,and not bungler like to boulster out an vnapt dial.

Chapter 77.

How to know the oblique ascention of any degree of the zodiacke,or of any starre the difference of ascention not regarded.

Cornelius Gemma 95.

COrnelius Gemma in the beginning of this chap. saith,that he hath hitherto performed those propositions,which he thinketh his father G.F.minded to haue done,& wisheth earnestly that his sayd father had made some table first, in the beginning of his worke,whereby he might haue hadde some light to haue gone further,but now being without guide, he determineth to conclude, with an addition or twoo of ascensions & reuolutions as follow.VVherefore to proceed in this chap.place the deg. of the Zodiack,or els any star on your horrizon on the East part,which done,reckon the deg.of the *limbe* between 6.of the clocke in the morning,and the beginning of ♈;you haue your desire.

Example. In our latitude vz.51 $\frac{2}{3}$.I would know the oblique ascention of the 20. deg.of ♉, I place the same deg.of the Zodiack on the 51 $\frac{2}{3}$ horrizon,and on the Northeast part, because it is a North signe:that done,I number in the *Limbe* from 6.of the clocke at morne vnto 0.in ♈.according vnto the course of the *primum mobile*,that is,from East by the South,and so VVest, I finde degrees,the oblique ascention of 20.degrees of ♌.Hereby is the right ascension to bee hadde,if in North signes yee subduct the oblique out of the right,& in South,the right out of the oblique ascention,looke more hereof in the 13,& 15.chapter.

Chapter 78.

The oblique ascention giuen to finde the degree of the zodiack coascending.

*Cornelius Gemma.*96.

REckon the oblique ascention in the *limbe* from 6.of the clocke in the morning towards the South, and so forwardes if need be,thereto lay 0.in ♈,and immediatly in the East part of your horrizon you shal see the degree sought for.

Chap.

Chapter 79.

Of the recourse and reuolutions of the yeeres of the worlde, necessary in natiuities and directions.

Cornelius Gemma. 97.

VNto the doctrine of setting a figure for natiuities, there appertaineth consideration of the annuall conuersion of the Sunne: for it commeth to passe that in the new circuit of euery yeere, there happen vnto our bodies new powers or influences of the starres by the *Energeia* of the Sunne, and not only the course of humane matters is chaunged, but buildings, cities, kingdomes, insomuch that the whole worlde is subiect vnto diuers & sundrie Metamorphoses and chaunges, by euery alteration of the lights, and theyr returnings vnto their beginnings. And that in succession of thinges the two most noble lightes of the worlde haue great power and effect. Ptolomeus witnesseth, who saith, that for chiefe cities which they call *metropoli*, the foreshewing and prophesiyng vpon them as it were, is chiefly to be taken out of those places of the Zodiacke, by the which at the time of their foundation or first building, the Sunne and Moone were founde to bee moued: euen as in natiuities, the chiefe house is the horoscope. For some doe iudge by the returne of the Sun into the same point, whence he went from the beginning, & that for the accidences of the whole yeere. Some also make account of the monthly conuersions of the Moone, for the successe of euery moneth.

VVherfore when you will set the annuall reuolution by helpe of this instrument, the place of the Sunne which he had in the Radix of the thing, called of the Greekes *Catarthyn* must bee reduced exactly by tables or instruments. And then the *label* layd vppon the houre found in the *limbe*, which determineth the beginning of the thing, let there be numbred according to the sequele of the houres from the rule for euery yeere passed 87. deg. 19. min. for euery 5. yeeres. 76. degrees 35. minutes: for euery 10. yeeres 153. degrees 10. min. and if the number gathered of these, doe exceed a circle, subduct 360. as oft as you may, and let the remainder bee accounted from the houre of the first beginning or Radix, whereto lay the *label*, and it sheweth the exact time, wherein the Sunne is come vnto the same point, wherefore if you place vnder the *label*, the same degree of the Zodiacke, you may there see the foure chiefe houses or Cardines, that is too say, the horoscope descendent *medium cœli* and his opposite, where you may set your figure, and iudge of the state of the whole yeere.

For example, I will propose the conuersion of the natiuitie of Phillip king of Spaine, for the yeere 1554. in which he marryed the Queene of England, this yeere was the 28. yeere of his age in succession, but there were but 27. fully ended, wherefore I cast how many degrees answere to these yeeres according to the rate before prescribed, I finde 557. deg. 31. minutes, out of which I take 360. and that as oft as I may, there remayne 197. deg. 31. min. too bee numbred in the compasse of the *limbe*, from the minutes past foure of the clocke at after noone, which was the Radix or time of his birth in the yeere 1527. the 21. of may. And this course or order of the numbers being perfourmed, the count falleth out at last on 5. of the clocke 51. min. beyng the time of the full circuite of the Sunne, and his returne vnto the same point of the Zodiacke, which he possessed at the time of his natiuitie: wherefore laying there vnto the 9. deg. 2. min. of ♊, there haue you the 4. principall houses: and the rest you may get as in the 45. chapter.

And if you will by like indeuour, behold the menstruall anfractions or monthly reuolutiõs of the moone, the certaine time of the annuall reuolution of the Sunne, now being had, adde thereunto 28. dayes, for the circuite of one lunary moneth, and then from the houre of the annuall conuersion, number 2. houres, and about 18. min. and to the ende thereof, lay the degree of the Sunne, which he had in the Radix, and so according to the same rate, for two, three, foure, &c. monethes or houres.

Chapter. 80.

Of progressions and diuisions as they bee called.

Cornelius Gemma. 98.

VVHatsoeuer is more required vnto the Iudiciall art is rather to bee sought in tables then by this instrument, yet for progressions which in olde authours are much in vse, they are thus gotten, you shall in the Zodiack account for euery yere passed one whole signe, frõ the very apheticall place: and 12. dayes, 1. deg. for one day, 4. minutes, whereby, if the ende of the account be notable for any forcible radiation, you may giue iudgement what shall be likely to happen almost euery day, so that by the way you take the Apheta or partes of fortune after the minde of Ptolome, those are the Sunne, Moone, midde heauen, horoscope, &c.

For the deuisors which the Arabians call Algebutkar, and will that in institutions of workes they bee chiefly regarded, take this method vnto the oblique ascension of the prorogator, adde the yeeres passed of the life that some reckon in the *limbe*, and by the 27. looke what degree of the Zodiacke, ryseth on the horrizon, with that part of the equinoctiall, for they shall shew the dyuisor of the Apheticall place.

The

The fourth booke of the Mathematicall *Iewel*: newly compyled and set foorth by Iohn Blagraue *of Reading Gentleman*: *conteineth diuers* Astronomicall Propositions, and vses of the Iewell, of his owne inuention, no lesse pleasant and commodious, then those whiche by other Authours haue beene founde heretofore on their sundrie Instruments.

Chapter 1.

An aduertisement of the Authour concerning necessarie Instrumentes.

HAuing in my thirde booke finished all the Propositions and conclusions, whiche haue been written by any authour heretofore vpon their seuerall Astrolabes lately: and lastly set downe, gathered togeather, and wonderfully encreased and augmented by that worthy and learned man Gemma Frisius, on his Cetholicon Astrolabe, and applyed all those too my *Iewel*, together with diuers of my owne additions, whiche performeth them an hundred folde more playnely, sensibly, and compendiously, then hys Catholicõ, as he that wyl trie both shall testifie: It were much for me now to come after so many learned men, and to bring in place any thing more worth the liking. Some wil think I go about to finish Apelles picture, that no mã yet durst vndertake: & perhaps say, who is bolder then blind bayard? or *Asinus ad Lyras*: knowing my rusticall education, and simple capacitie. VVell, bee as be may is no banning, such a ones words are not worthie the scanning, hee that feareth euery grasse must not pisse in euery medow. Babling tongues be hanging type, I wey not theyr glauering, I acknowledge my learning little, and truly my leasure lesse, notwithstanding as much as lyeth in my lot I will shewe my good intent in these volumes following. The rest I leaue to those that haue better wherewithall: to whom I yeelde my labours but as a preparatiue. The shoemaker can goe no further then the shoe, neither can the tayler make his coate bigger then the cloath wyll yeeld. Such as it is, yet I doubt not but it will bee liked of some at the least. Therefore too the matter, I woulde wish any man that woulde more effectually go to worke in these matters, ouer and besides his little portable *Iewel* of mettall, which I taught to make in the first booke that must be his companion in all companies, and his page in all places, to haue neuertheless at home in his chamber or studie, a great *Iewell* of two foote diametre, if not of mettall, yet made of a round boorde, couered with a fine paste boord, whereon hee may distinguish the necessary lines with coloured ynkes very beautifully. The *reet* he may make of like paste boord, which hadde neede too bee made of good strong paper royal, foure papers in thicknesse, for neither is your bought paste boord broad enough, nor good enough: the cẽter of this paste boord *Reete* wold be lined with a thin plate of brasse for wearing: I made my selfe one of them that serued me to great purpose, and therefore I am sure I tell you true. Let your spaces of your meridianes and your paralelles in the *mater*, be degrees a peece at the most, and so likewise your azimuthes and almicantares in your *reete*, yet it is better that those almicantares, that you cut out be eche a degree, & the other that you leaue in like barres or the spiders web, to be eech but halfe a degree: for if you will haue your worke sufficiently transparent, two partes at the least must be cut out, and a thirde left in. Also bee sure that you deuise to leaue strings enough, in placing your starres, and cutting out the lower part of your *reete*, that the paste boord may beare out it selfe, and drawing them like braunches handsomely, the *reete* will shew the fayrer though they be not necessarie. I did also at euery 15. azimuth, leaue a string, a degree in breadth from the *finitor* to the Zenith, to keepe my almicantares a part at their true width, take heede you wishe not you had done so too when it is too late. In euerye of these stringes I did write the numbers of my Almicantares from 5. to 5. &c. tyl 90. And then if you had two other, the one made for a globe terrestriall, and the other celestiall, the meridianes and parallels, 5. degrees wide a peece, as hereafter in my Cosmographie shall be shewed, and beyng all three of equall bignesse, one *reete* may serue them all, they will be verie pleasaunt. These had, you are in heauen alreadie, except you chance to be in loue with a quadrant, and the crosse staffe, which in or before my booke of longitudes of regions, I wyll teach to make, without which you cannot be, if you will pearce vnto the exactnesse of euery thing.

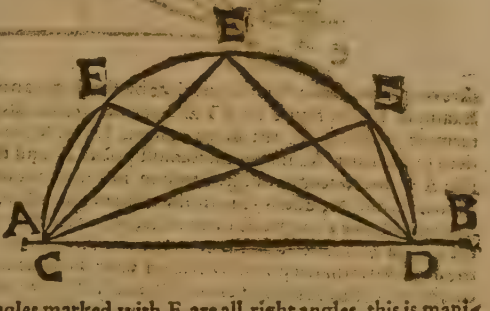
Chapter. 2.

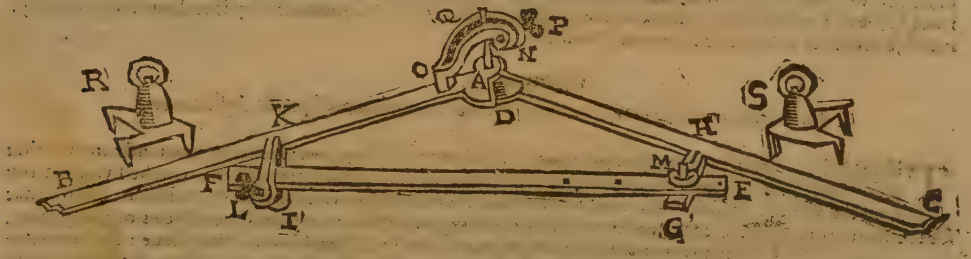
How to make an instrument of three streight rules better then any compasses to describe any arch with, be his center neuer so farre off.

IN making my *Iewell* on a boord of two foote diametre, I was not a little troubled to drawe the arches of the meridians and paralels, which come neereste too the center, and therefore I should doe you wrong if I should leaue you to seeke in that behalfe, truly I hadde deuised to make a beame compasse of a lauelin or

speare

ſpeare of 18. foote long, and yet neither would that length reach all my centers nor draw any arche without ſagging: inſomuch that I was driuen to finde to make them without any kinde of compaſſes by ſhorte ſtreight lines drawen from 10. degrees to 10. degrees, &c. the which I had thought wyth a long circumſtaunce heere to haue ſet foorth for theyr better helpe, that ſhould attempt the like. But in the meane time came a little booke to my handes of one *Guydo Vbalbus de Theorica Aſtrolabii*, wherein I founde a very ſleight inſtrument, made of three rules, to perfourme theſe great arches eaſily, which I ſought by great ambages. VVhē I ſawe it, I was almoſt out of conceite with my ſelfe for the time to thinke that my groſſe witte coulde not deuiſe it before: for I no ſoner ſawe a glimſe of it, but ſtreight I perceiued the reaſon without reading of anye woorde in the booke: and more then that I coulde ſtreight goe too the tree where *Vbalbus* gathered that frute though he himſelfe concealed it: namely, the 20. propoſition of the thirde booke of Euclides elements which ſayth thus, *If in one portion of a circle there be made diuers angles touching the circūference of the arch* (the corde of the ſame arche, beeing baſe vnto them all, for that is his meaning as appeareth in the Cōment) *all thoſe angles are equall one to another*. Alſo in the 30. propoſition of the ſame booke hee ſheweth that all angles in a ſemicircle touching, the arch be right angles, as in my ſecond concluſion appeareth, which proueth alſo ỹ former in reſpect. A ſemicircle is but an arche. For your better vnderſtanding beholde, theſe two figures in the Arche, Y X the three angles marked wyth A, hauing all of them the corde of the arche to their baſe, are euery one equall eche to other: likewiſe in the ſemicircle C D, the three angles marked with E, are all right angles, this is manifeſtly prooued in Euclide by demonſtration, & you your ſelf may experimentally examine the equalitie of theſe angles if you liſt, by the 10. cōcluſiō in my firſt book. But let this paſſe, I wil ſhew you the making of ỹ Inſtrument ſomewhat more commodiouſly then *Guydo Vbalbus* hath ſet foorth, and leſſe comberſome, which by this bare figure following will appeare better then by manifolde woordes, and therefore beholde it wel,



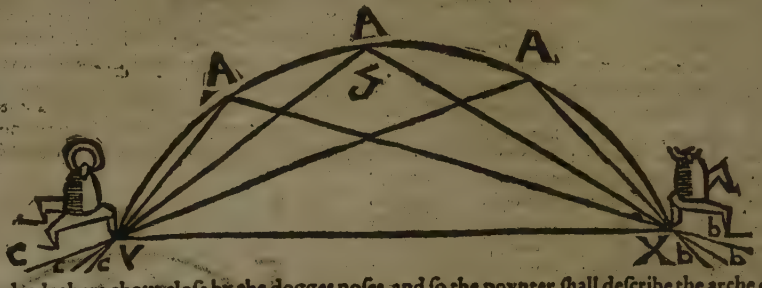


A B, and A C are twoo ſtreight rules ioynted together like a payre of compaſſes, at A, but ſo that the ioint A, muſt bee as ſmall as may be poſsible, the riuet being hollowe, and as bigge as may containe a crowes quill: then betweene A D are broade cheekes to helpe ſtrengthen the ſmalneſſe of the riuet. H G ſhoulde bee very neere one thirde part in length of A B or A C, hauing neare the ende G A a rounde pin erected whereon the thirde rule E F is put, and then the ſcrewed boxe M keepeth hym on the rule. E F hath three or foure holes towardes the ende E, to keepe him backe from ſhutting ouer the rule A B. Alſo K I is equall in length to H G & is double, or rather ſlit, ſo that the lower iaw is equal in thicknes to H G, & the vppermoſt thinner: whiche the ſkrew pinne L doth force together, to holde faſt the rule E F, when neede is. N O is not much vnlike to K I: yet for faſhions ſake it is made ſomewhat like the cocke of a qualifier or gunne, and ſtandeth an inche aboue the rule A B with a foote, his office is to hold a penne or a ſteele pointer faſt, being put in the hollowe riuet A, that it ſtirre not in grauing, to which purpoſe one checke muſt bee thicke, and the other thinner, as K I was. Q is the ſteele pointer or grauer, whiche beeing put through the chappes of N O into the hollwe A, is there holden faſt by the ſkrewe pinne P. Thus muche for your inſtrument: But to helpe him to worke, he muſt haue the aſsiſtaunce of two dogges as I call them, ſuch as you ſee R and S, whiche haue each a waight of leade faſtened on their backes, their height muſt not exceede 3. quarters of an inche, that N O may ryde ouer them, the formoſt foote, whiche I call the noſe of the dogge muſt bee made like the blade of a knife, and the edge a little blunted, and ſet forwardes, but verye ſtreighe downe, and the backe befiled away vnto a point.

Chapter 3

The vſe of the former inſtrument in drawing of any Arche.

THE vſe of this trianguler compaſſe, is by three prickes giuen too deſcribe an arche, cutting them all three: whiche too doe you muſt ſette the twoo dogges their noſes in the two vttermoſt prickes, whereto applie the edges of the two rules containing the angle A, ſo that the pointer or grauer that is in the hollowe riuet A, bee in the midlemoſt pricke, and the three rules there faſtened by helpe of the



skrewe pinnes, leade them about close by the dogges noses, and so the poynter shall describe the arche desired. Example, in this figure let X Y Z bee three prickes assigned: first I set the two dogges noses in the two vttermost prickes X Y, the skrewe pinnes L and M, being first at libertie, I place the pointer Q, which standeth in the riuet A, in the midlemost pricke Z, and there holding hym downe, I open the rules vntyll the side A C doe touch the dogge standing in Y: and the side A B touch X, which done, I wring hard the skrew pinnes L and M, and so is your instrument set fast in his angle. Nowe neede you but like a mower with hys Sythe leade along these three rules, so that the side A B doe still touche the dogge standing in X, and A C the dogge M Y, and so shall the pointer in A, describe an arche as true as any compasses whatsoeuer. For the dogs shal still keep you so within your bounds that you shall not choose, but mowe your swathe true compasse. In this figure the lines A B, and A C, do represent the sides of the rules, which because they include one angle whose base is X Y, therefore in respect that X Y doth alwayes keepe the Angle A, at one base the angle A must needes finde out the circumference of the arche as he goeth, as appeareth by the figures of the last chapter, by this you may gather also, that the two rules *A B* and A C, must bee at the least as long as X Y, if they be longer, it is superfluous for this arche, but perhaps may serue another the better, and thereby for my purpose you may cõclude that your two rules need be no longer then the diametre of your *Iewell* because the two prickes fartheſt distaunte are the extreames of the diametre, so that one of these made of 3. rules, eache sixe inches long, wil make a *Iewel* of sixe ynches diametre: the best way is to haue two, one of 9. inches, another of twentie or foure and twentie.

Chapter 4,

Of a certaine secrete in diuiding the meridians of great Instruments.

THough this inuention with three rules bee so excellent to drawe great arches in great instruments that all other deuises be almost friuolous, yet wyll I shewe you a great secret or two, whiche I vsed for my helpe before the same was knowen, not because I woulde haue you vse it in that behalfe: but for that I haue founde great pleasure, & necessitie of it in working other inuentions and proiections of the spheare, For Astronomicall dials, mappes, and other matters more then I will speake of till time serue: in the meane season make account of it. If you remember, in the seconde booke and eight chapter, I shewed you to deuide he two halues of the Zodiacke from their seuerall poles: assure your selfe in very lyke manner, prooue it when you will, may you deuide any meridian of the *Mater* into the same diuisions that any of them is deuided by the parallels, and that without drawing the parallels, if in the noone line you seeke the center or rather pole of any suche meridian as farre backwardes within the center of the *mater*, as the meridian that shoulde bee deuided lyeth within the *limbe*. For example, if you woulde deuide the 30. meridian, counted from the *Limbe* on the South halfe of the *mater*, seeke then where the 30. meridian, from the center on the North halfe of the *mater*, doth crosse the noone line: and there is your pole or center most assuredly, whereon keeping the one end of a rule, and laying the other ende on euery of the deg. of the South halfe of the *limbe*, eache after other: you may thereby deuide the saide 30. meridian, euen as eyther halfe of the Zodiacke was deuided from their seuerall poles in the said second book and eight chapter. And when this 30. meridian is thus deuided, you shall finde those diuisions equall to those, which are made by the crossing of the parallels, which you may sufficiently gather by the last way, which I taught in the seconde booke and nienth chapter, to deuide your Zodiack by. I say in this maner may you denide any of the meridians if you seek his pole in the noone line, as farre beyonde the center as the meridian is within the *limbe*, and thereon as from a center deuide him by the opposite halfe of the *limbe*. For in very truth, as I say, that point is the very pole of euery such meridian, as in my next booke of spherical triangles will appeare. And thus may you not onely deuide the meridians but generally euery arche whatsoeuer, representing a great circle or semicircle of the spheare, which is specially to bee accounted of, and wil, beyng ioyned to the 4. and 6. chapter of the seconde booke, yeeld exceeding fruite and pleasure in proiecting of the globe. Before the inuention of the said three rules I was determined in making of great instruments to deuide euery 5. or 10. meridian in this manner and then by short streight lines to drawe the parallels.

Chapter 5.

Another secrete founde by the Authour in deuiding the parallelles of great Instrumentes.

FOr asmuche as the time hath beene with mee, and may bee againe with you in making great quadrants of 7. or 10. foot side, or great astrolobes, that you wold becõtent to know how to diuide fom one parallel or

other

other into the very ſame diuiſions, whiche hee is, or at leaſt ſhould be deuided into by the meridians, though you thinke perhaps you ſhall not greatly vſe it, and I thynke I ſhall neuer haue the neede therof, I haue had, yet will I not omit to ſhew it, leaſt at a time you woulde wiſh you knewe it. Admit therefore for example that you had drawen the fortie & fiue parallel, how coulde you now know where euery meridian beeing truly drawen ſhoulde croſſe, you cannot tell: then ſay I, thus doe. Let the point of the 45. degree of the *limbe*, that is to ſay, where the 45. parallell toucheth the *limbe*, be vnto you inſteede of a center, on which point laying the one ende of a rule, mooue the other ende from degree to degree of the further half of the noone line beyond the center, and thereby deuide the one half of the ſaide 45. parallel, which deuiſions (if your rule be ſtreight and you worke truly) ſhall without all doubt be equall to thoſe diuiſions which the meridians do make. And ſo may you deuide any of the parallels eſpecially thoſe betweene the 45. parallel, and the pole exactly, but thoſe that lie towardes the Equinoctiall, cannot ſo exactly bee deuided in this manner, by reaſon that the rule wyll cut them ſo byas, or oblique that the pointes of interſections can ſcant bee founde. I feare mee, I ſhall haue occaſion to vſe theſe in making my great quadrant, and therefore I leaue out further demonſtration till then. The time was when I had writte more of theſe matters then I meane nowe to publiſhe. For I haue been driuen by helpe of thoſe diuiſions too drawe the meridianes partly by ame.

Chapter. 6.

Of drawing and dyuiding of the eclipticke line on the Mater.

THE eclipticke is, or ought to bee drawen croſſing the center of the *mater* to touch the one ende of eyther Tropicke at the *Limbe*, videlicet, leing byas to the Equinoctiall according to the Sunnes greateſt declination $23\frac{2}{60}$. degrees, as in the ſecond booke, and fifth chapter, and ought to be deuided into the very like partes or degrees as the Equinoctiall is. VVherefore if you croſſe this eclipticke line ſquare on the center, with a blinde line it ſhall touch in the *Limbe* the one ende of eyther pole circle, where doubt you not, but the poles of the eclipticke are. Therefore from eyther of thoſe points you may deuide him, by laying the rule on euery degree of the halfe *Limbe* fartheſt off from the ſame point, as in the ſecond booke, and fourth chapter, the Equinoctiall line was deuided from one of his poles: then ſet too the Caracters of the Signes, the beginning of ♈ and ♎, to be at the center: & of ♋ at the *Limbe* or endof the Eclipticke on the right hand, ♑ at the left: the reſt in order as I hope you knowe by this time. You ſee here that the reaſon of this differeth not from the deuiding of the meridians mentioned in the fourth Chapter. For the ecliptick being the great circle of the ſpheare, and lying 90. degrees within the *limbe*, towardes the center, euen croſſing the center: therefore hys gole muſt needes be 90. degrees from the center, which is at the *limbe*.

Chapter 7.

By the verticall circle or azimuth of the Sunne or Starres, taken to knowe what it is a clocke, very certainely and exactly.

HAuing now inſtructed you for the making of a great *Iewell* of two foote diameter, it is conuenient that I ſhewe ſome vſes needing hys capacitie, notwithſtanding that all the thirde booke wyll bee gladde of his acquayntance. I would haue no man preſume too much of a ſmall inſtrument be he neuer ſo exquiſitely made: in matters requiring great certaintie, there can no man worke ſo truly with a ſmall as with a great. For although that ſmall inſtrumentes in mathematicke ſpeculation be ſufficiently certaine to lead a manne to knowledge of thinges, yet there is no doubt but *Maiora ſemper ſunt certiora in mathematica practica*, neither is it poſsible to vſe any ſo great as in ſome caſes woulde be required. It is ſhewed in the ſixth chapter and third booke, how to knowe what it is a clocke by the altitude of the Sunne, but becauſe the Sun, and likewiſe the ſtarres in an houre before and after noone, euery day riſe and fall very little; therefore a ſmall myſſe in the altitude taking, may make a quarter or halfe an houres errour: beſides that, the interſection of the Almicantare, with the parallel of the Sunne, or any ſtarre neere the South, lyeth very byas, and ſpecially in South ſignes and ſtarres, whiche may make more errour for want of the point of the true interſection then may well be allowed in ſome caſes. VVherefore the trueſt and moſt certaine way to come by the knowledge of the houre, and ſpecially *ad minutum*, which in the rectifiyng of the ſtarres, planets, &c. and getting the longitude of regions is very needefull, is by azimuth, becauſe he alwaies croſſeth the parallel very diſtinctly, and is (the meridian line firſt had) to be found very certainely. It is ſhewed in the third booke 36. chapter, by the azimuth and altitude taken, to knowe both the latitude and the houre: but here by the azimuth, and latitude giuen, is had both the houre and the altitude of the Sunne or ſtarre, prouided that the degree of the Sunne in the Zodiacke, with the ſtarres declination be alſo knowen. Take either by helpe of a Topographicall inſtrument or els by the thirde booke and 35. chapter, the azimuth of the Sunne or any knowen ſtarre, which had, ſet the *Finitor* to the latitude, and marke where the like azimuth of the *reete* dooth cut the parallel of the Sunne or Starre, the meridian croſsing there, ſheweth the houre and the almicantare croſsing there, ſheweth the altitude, yet in the ſtarres this houre is but *Hora ſtellæ*, the ſtarres houre, by which you may get the true houre, as is ſhewed in the thirde booke and 26. Chapter, remembring alwayes that *Locus Solis oſtendit horam*, this needeth no example, it differeth not much from the ſaide 36. chapter. Further all the difference from the ſixth chapter of the thirde booke is, that here you woorke by the azimuth as there you did by the almicantare.

Chapter 8.

By the latitude of any planet and his diſtaunce from any knowen fixed ſtarre had: how to get his exact longitude.

BEcauſe in the firſt chapter of this booke I counſailed you to adde vnto your great *Iewell* the croſſe ſtaffe, I thought good to ſhew you, partly by this chapter, that he will ſerue you to neceſſary purpoſe. VVherefore according to Gemma Friſius inſtruction in his booke *de radio Aſtronomico*, you ſhal by the croſſe ſtaffe take the diſtance of any planet you ſhal ſee in the heauens, whoſe longitude you deſire, frō ſome one knowē fixed ſtarre, that is to ſay, ſuch a ſtare whoſe longitude and latitude is knowen: which had, you ſhall then reſort to the *Ephemeris* or ſome other like tables, and get the latitude of the planet for that day, nowe place the Zenith poynt of your *reete* ſo many degrees of the *limbe* aboue the equinoctiall, as the latitude of the fixed ſtar commeth to: the *reete* there fixed, marke where the Almicantare counted from the zenith point, equall to the diſtance taken by the croſſe ſtaffe, doth cut the parallel counted from the equinoctiall, equall to the planets latitude had in the *Ephemeris*, and the meridian croſsing there with them, followed too the equinoctiall line ſhall ſhewe you theron the deg. and min. of the difference of longitude betweene the ſtarre and the planet, which if the planet be Eaſtwardes of the ſtarre, you ſhall adde to the ſtarres longitude, if VVeſtwardes, ſubduct it, and ſo ſhall you haue the longitude of the planet deſired: remembring this by the way, that if the latitudes both of the ſtarre and planet be one way, that is to ſay both North or both South, then muſt you after you haue placed the zeneth point at the *Limbe* fixed as before, take the ſaid parallel on the ſame ſide of the equinoctiall, as the zenith point is: but if the one bee North, the other South, then take the ſaid parallell on the further ſide of the Equinoctial.

For example. The 14. day of October 1582. about 6. of the clocke in the morning, I tooke the diſtāce of the firie redde planet, ♂, from the great ſtarre of the light called *humerus dexter orionis*, Oriones right ſhoulder, by a croſſe ſtaffe of my faſhion for want of G.F. and founde the ſame 31. degrees 37. minutes. and 30. ſecondes, for my ſtaffe was large. The latitude of the ſaid ſtarre of Orion, is, and euer hath been, and therefore this working is the more certain, 17. degrees ſouthwardes from the eclipticke, which by my tables of fixed ſtarres, you may finde: the latitude of ♂, by *Leouitius Ephemeris* was then one degree verye neere Northwardes, theſe had, I reckon on the *Limbe* from the equinoctiall towardes the South pole of my *Iewel*, the ſaid 17. degrees, being the latitude of Orion: thereto I place the zenith point of the *reete* fixed: then among the parallels towardes the North pole, I reckon one degree beeyng the latitude of Mars, found in the *Ephemeris*.

Nowe then where the $31.\frac{37}{60}$. almicantare counted from the Zenith doth cut the ſaide firſt parallel (for I leaue out the ſecondes in ſmall ioſtruments) there doe I ſee the $26\frac{1}{4}$. meridian counted from the *Limbe* to croſſe, the ſame was the difference of longitude betweene the ſaid ſtarre of Orion and Mars at that inſtant. The longitude of that ſtarre after Stadius is 23. degrees in ♊, and at that time I ſawe Mars Eaſtwardes of this ſtar. Therefore I adde this difference here found, vz. $26\frac{1}{4}$. to this longitude of the ſaide ſtarre being 23. in ♊, and counting it according to the ſequele of the ſignes, it falleth out too bee the 19. degree & 15. min. of ♋. which I conclude to be the place of Mars, his longitude at that inſtant. But ſome will here ſay to what purpoſe is this if wee goe to the *Ephemeris* for the latitude of the planet, then were it as good to take the longitude there alſo. True it is in ſome reſpect, but yet ſhall you ſee commonly that *Ephimerides* will differ in the longitude of the planets one from another, beſides, when *Ephemerides* are made by diuers men to diuers longitudes, then may they differ, and yet be both true. VVherefore by this chapter you may with greater ſpeede then Gemma Friſius or any other hath before taught, for ought that I euer read, both examine the truth of your *Ephemeris*, and of diuers of them, which is the trueſt & moſt neer to the longitude of your countrie. And though in their *Ephemerides* they ſhoulde differ muche in the longitudes of the planets, yet they cannot erre greatly in the latitude, if they doe, a little cannot hinder your purpoſe in working after this chapter, ſo you take your diſtaunce truely, as for the purpoſe you ſhall finde there that ♂ goeth but 2 minutes in latitude euery day, ſo that where before you tooke one degree or 16. minutes: if you had taken 60. minutes, which is the latitude of ♂ two dayes before, and wrought as before, you ſhoulde haue committed no ſenſible errour in the longitude. Though this experience be moſt pleaſant to examine the places of the planets, yet meddle not with the Moone: for her tickle ſwift courſe found in tables, and her vntowarde parallaxe in takyng her diſtance, will diſappoint you. But if it pleaſe God to lend mee life, and that this wrangling worlde alow mee leaſure, wherein theſe ſixe or ſeuen yeeres I haue fared like a tenniſe ball toſt vp and downe, I wyll in my boke of longitude of the places, ſo ſufficiently prouide you for euery ſhuttle nycitie of the Mone, that ſhe ſhall haue no ſtarting hole to deceiue you. You ſhall be fully inſtructed to meete her at euery turne, yea euen to leade her in a ſtring, as they ſay, and that at pleaſure. Then ſhall her defuſe motion in her buſie ſpeeres with her euerdaring parallaxe (which hath heretofore ſtalled the moſt, and incumbred the beſt learned, yea and deceyued ſome of them, as I ſhall there manifeſt) be ſo broade and playnlie opened by my ſimple induſtrie, that all ſortes ſhall wonder at the facilitie thereof. And therefore let all Coſmographers, Nauigators, Shipmaſters, Trauailers, and ſuch like, clap their handes for ioy, of this *Iewell*.

Chapter 9.

How at all times you may beholde on the Mater *of your* Iewel *the whole circumference of the ecliptike, according to his cituation, aboue the horizon, which bringeth with it pleaſant vſes as followeth,*

FIrſt place the deg. of the Sunne in the Zodiacke, to the houre propoſed, reckoned on the *limb*, & there preſently ſhall you ſee the aſc, on the Eaſt part of your horrizō by the 3. book 42. cha. & his amplitude by the

first part of my addition to the 20. Chapt. of the third booke: The degree of culmination or midheauen, you haue there also by the 3. Booke 30. Chapt. and his meridian altitude by my addition to the 3. Booke 29. chap. there present all these are had at one inspection, by applying the degree of the sunne to the houre proposed. Then to proceed, nnmber the meridian altitude of the degree of culmination on the *Limbe*, from the pole articke towards the right hand, if the ascendent be a north signe, but leftwards if he be a south signe: to the end of this numeration place the *Finitor*, which done, reckon on the *Finitor* from the centre outwards, the ascendents amplitude and that alwayes leftwards or towards *Media nox*, and mark what meridian of the *Mater* doth cut on the *Finitor* the said degree of amplitude, the portion of the same meridian from the *Finitor* to the pole, representeth the arch of thecliptick from the ascendent to midheauen, & the meridian of like distance frō the axtree line on the other side which also cutteth the like amplitude on the *Finitor* his portion betweene the pole and the *Finitor* representeth the arch of thecliptike from midheauen vnto the descendent.

Example. Our most towardly and vertuous young Prince and king, Edward the sixt was borne 1537. the 11. of October the 13. houre 51. min. the sunne then being in ♎ 28. deg. wherefore I would see the constitution of thecliptick to the horizon on my *Iewel* that thereby I might set the figure of his natiuitie, as I wil shew in the 13. and 14. Chapt. following. First therefore I set the deg. of the sunne vz. ♎ 28. vnto the 13. houre 51. min which is one of the clocke after midnight, and 12. $\frac{2}{3}$ degrees past, where I see in our horizon being 51. $\frac{2}{3}$ the ascendent ♍ 5. deg. almost, whose amplitude is 16. deg. $\frac{1}{2}$, and likewise the degree of culmination ♉ 26. deg. whose meridian altitude is 57. $\frac{1}{3}$ deg. These had, I reckon the saide meridian altitude vz. 57. $\frac{1}{3}$ deg. on the *Limbe* from the pole articke rightwards, that is towards noone, becaus the ascendent is a north signe, thereto I set the *Finitor*, whereon from the centre northwards or leftwards, I reckon the ascendents amplitude vz. 16. $\frac{1}{2}$ deg. and there do I finde to cut the *Finitor*, the 14. meridian counted from the axtree line, whereby I conclude that the arch of this 14. meridian between the pole and the *Finitor* is now the arch of thecliptick betweene the midheauen and the ascendent, so that the pole being now the 26. of ♉, rekon thense from the same 14. meridian degree after degree as they follow in order on thecliptick, which by helpe of the parallels you may easily do, and you shall finde that the last number at the *Finitor* will end in the 5. deg. of ♍ which is the ascendent. Lastly the arch of the 14. meridian on the other side of the axtree line between the pole & the *Finitor*, is here the arch of thecliptick between midheauen and the descendet, cutting on the *Finitor* like deg. of amplitude, and being accompted from the pole, that is from 26. of ♉ backwards, contrarie to the sequele of the signes, it wil end in 5. of ♓, which is the descendent. This 14. meridian or any like, I must for distinctions sake hereafter call thecliptick circle.

Chapter 10.

By the Eclipticke circle constituted as in the last Chapt. how to get the altitude and azimuth of the sunne or any point of thecliptick, and thereby also of the other planets so they haue no latitude.

THecliptick circle being situate as in the last Chap. to the *Finitor* for any instant proposed, reckon thereon the deg. of longitude of the sunne or any other planet, not hauing latitude either from the midheauen if he be on the East part, or from the descendent, if on the west, because so may you reckon according to the sequele of the signes, better then from the ascendent vpwards, or from midheauen towards the descendent: where your reckoning lighteth out on this ecliptick circle, the azimuth and almicantare crosing there, sheweth your desire.

Chapter 11.

By the same constitution of thecliptick circle how to finde his Nonagesimus gradus *with the altitude thereof, being the quantitie of the angle made betweene thecliptick and the horizon.*

IF from the ascendent you reckon on thecliptick circle vnto 90. deg. there is your *Nonagesimus gradus*, & the almicantare cutting, or rather touching there, is the altitude.

Chapter 12.

How by the same constitution of thecliptick to see all the circles of position liuely on the Iewel, *and what degree of the zodiacke is in any of them.*

THis is performed onely by setting the zenith line to the constitution insteede of the *Finitor*, as for example: If in the 9. Chapt you had set the zenith point of the *Reete* 57 $\frac{1}{3}$ deg. vnder the pole, there do the azimuthes represent all the circles of position crosing thecliptick or 14. meridian whereon you may reckon what degree euery of them cutteth which is your desire.

Chapter 64.

How by the same constitution of thecliptick circle to set a figure verie sensible and apparantly.

FOr this purpose you must haue your foure domifying position circles distinguished on the *Reete*, as In my addition to the 3. Booke 49. Chapt. is shewed, and you shall finde those 4. with the zenith line in this

conſtitution, and the *Limbe* to cut in the ſaid eclipticke circle, the degrees beginning euery of the 12. houſes whereby you may eaſily ſet the figure, remembring that by the one halfe, the whole 12. are had.

Chapter 14.

How to ſet a figure with more pleaſure and eaſe, the laſt Chapter well vnderſtood, ſo that you may beholde your whole 12. houſes in their being altogether on your Iewel.

HEere my appointment was that the azimuthes and meridians ſhould chaunge their offices, ſo that the 14. azimuth ſhould repreſent the eclipticke circle of the 9. Chapter: and the meridians ſhould repreſent the circles of poſition by placing the zenith point of the *Reete* 57½ deg. aboue the pole, and (the domifying poſition circles, being firſt diſtinguiſhed among the meridians) there ſhall they cut the 14. azimuth in manner of the laſt Chapt. and thenſe following the almicantares cutting there with them, vnto the *Limbe*, make prickes or notes on the *Limbe* of the *Reete* for euerie of them, and ſo are your 12. houſes had without any numbring at thoſe prickes, of which the zenith point of the *Reete* is alwayes one, yea and the beginning of the 10. houſe: then if about the *Limbe* of the *Mater* the 12. ſignes bee ſet and deuided, and amongſt them you chooſe out the *Gradus medii cæli* for the inſtant propoſed, and thereto ſet the zenith point of the *Reete* fixed, there do the reſt of the prickes euery one chooſe out the deg. beginning the houſe he ſtandeth for, which are eaſily counted from the 10. houſe, here you ſee there is no numbring at all.

Chapter 15.

How to get the altitude of the Nonageſimus gradus *more readily then in the* 11. *Chapter is expreſſed.*

THe houre and minute giuen, get the aſcendent and his amplitude, and alſo the degree of culmination with his altitude, and thereby place the conſtitution of theclipticke circle, as in the 9. Chapter is expreſſed aboue the *Finitor*, and then marke what almicantare doth but onely touch theclipticke circle, the ſame reckoned from the *Finitor* is the altitude deſired.

I haue giuen ouer theſe 6. Chapters laſt paſt being indeede ſome of them very tedious and long, as one verie loth to trouble my booke with ſuperfluous matter, for in truth they tended chiefly to the ſetting of a figure, which when all is done, will (though perhaps not ſo liuely, yet more ſpeedily) be performed by the third Booke 46. Chap. but I haue let the titles ſtand, to the end that ſuch as liſt may the eaſier boult out the matter of themſelues.

Chapter 16.

How to place theclipticke aboue the Finitor *after another ſort then is ſhewed in the 9. Chapter, and in the ſame conſtitution to finde out euery needfull circle, whereby moſt excellent concluſions are to be performed.*

THis conſtitution did Gemma Friſius finde out by his Aſtrolabe, as in the 2. Booke 54. Chap. appeareth, yet ſeruing there onely to get the bare altitude of the ☉ or planets, not hauing lat. which by the 6. Cap. may alſo be done, but my *Iewel* by the explanation of this Chapt. and the helpe of his almicantares and azimuthes, performeth the ſame to great and wonderfull purpoſes as will more appeare in my Booke of the longitudes of places then in this 4. Booke. Wherefore either by the ſaide 54. Chapt. place the *Finitor* as there is ſhewed, or elſe by the houre giuen, get the *Nonageſimus gradus* either by my addition to the 3. Booke 53. Chap. of the 3. Booke, or by the 11. or 15. of this booke, and reckon his altitude on the *Limbe* from thequinoct. line vpwards, thereto laying the *Finitor*, but on this condition that if the matter you purpoſe be in latitude North of theclipticke, then let the almicantares ſtand vpwards towards the north pole, if ſouth then downwards towards thequin. & there is your *Iewel* in a ſinguler conſtitution ſeruing many pleaſant & profitable concluſions as ſhall follow, wherfore I think it moſt neceſſarie to ſhew or explane the reaſon therof, thequin. line here repreſenteth the *Finitor*, and the parallels & meridians repreſent almicant. & azimuthes, the *Finitor* repreſenteth theclipticke, his point at the *Limbe* the *Nonageſimus gradus*, and at the centre the aſcendent and deſcendent. The almicantares and azimuthes are circles of longitude, and latitude of the zodiacke. The *Limbe* is the circle of longitude of the *Nonageſimus gradus*, which iſſuing from the pole or poles of theclipticke alwayes paſſeth by the zenith, the centre of the *Iewel* is the aſcendent and deſcendent, and not the Eaſt as it is in the 9. Chap. and all other vſes of the *Iewel* moſt commonly. But here the Eaſt and weſt points are diſtant from the centre as much as the amplitude of the aſtendent or deſcendent commeth to, and likewiſe the miridian as much diſtant from the *Limbe*, ſo that in briefe the *Iewel* here repreſenteth the globe wreſted from the meridian vnto that azimuth, which cutteth the *Nonageſimus gradus*, it is moſt manifeſt that all great circles in the ſphere are concentricke to the ſphere, and deuideth other in halfe, howſoeuer they be drawne or groſſe ech other as I haue often ſaid, and as in the definitions & theoremes before my ſpherical triangles following ſhal appeare, wherefore when as the *Nonageſimus gradus* is appointed in the *Limbe*, the aſcendent and deſcendent being alwayes 90. deg. diſtant equally on ech ſide from it, muſt needes be in the centre, which of neceſſitie muſt be the place of croſsing of the *Finitor* with theclipticke being both of them great circles, and twiſe 90. being a ſemicircle. But although that theclipticke do alwayes deuide the horizon in equall parts, yet he doth it continuallie in chaungeable places by reaſon that hee lieth byas to thequinoctiall, hauing for that cauſe no vniformitie

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in his motion, by reaſon whereof the altitude of the *Nonageſimus gradus*, is continually variable euerie moment, and ſo alſo is the altitude of the degree of culmination, or any other part of the zodiacke. Likewiſe the aſcendent and deſcendent cutteth euerie moment in ſundrie pointes of the horizon: whereas the Equinoctiall, and all the other parallels cutte the horizon continually in one point and their meridian altitudes are alwayes one, inſomuch that the *Iewel* being ſet at any time to that conſtitution, which this Chapter teacheth, the Eaſt and VVeſt point cannot be in the centre of the *Iewel*, but onely when the beginning of ♈ or ♎ is aſcendent for then the *Nonageſimus gradus* being ♋ or ♑ muſt needes be in the meridian: at all other times the aſcendent cutteth the horizon either North or ſouth of the Eaſt, which is called the amplitude *all* in the thirde booke 20. Chapter appeareth, and according to this amplitude ſhall the Eaſt point on the *Iewel* be remoued.

Chapter 17.

How by the conſtitution of the 16. Chapter to get both the altitude and azimuth of the ſunne or any point of thecliptick, or of any other planet or ſtarre, how much ſoeuer they ſhall be in latitude.

HOw to get the altitude of the ſunne, or any point of thecliptick, by this conſtitution hath beene taught by G.F. as in my 3. book 54. Chap. appeareth, but for any planet, ſtar or point of the heauens hauing latitude you are there neuer the neare, nor yet for the azimuth although it be had in the 11. Chapt. after another conſtitution for any point of thecliptick. Now therefore by the houre and minute propoſed, haning ſet your *Iewel* to the conſtitution of this laſt Chapt. you ſhall by the 3. booke 20. Chapt. learne the amplitude of the aſcendent for that inſtant, which if it be of a North ſigne, you ſhall reckon on thequinoctiall line, which heere repreſenteth the *Finitor* from the centre rightwards towards noone, and there is your Eaſt point, and the meridian or houreline cutting there, repreſenteth the Eaſt azimuth, but if your aſcendent be a ſouth ſigne, then count the amplitude leftwards towards *Media nox*, and there ſhalbe your Eaſt point and your Eaſt azimuth, which point and azimuth being found, you may eaſily reckon from thenſe your azimuthes, and that alwayes rightwards towards the *Limbe*, and thenſe backwards againe, and ſo round as occaſion ſhall ſerue; remembring that the 90. azimuth from this Eaſt point ſo counted muſt needs be your meridian.

As for example, in the natiuity of our vertuous king Edward, the altitude of the *Nonageſimus gradus* was 58 $\frac{1}{2}$ deg. by the 11. or 15. wherefore that reckoned on the *Limbe* from thequinoctiall and the *Finitor* thereto laid, then doth it repreſent thecliptick circle placed to this ſaid conſtitution, the aſcendent and deſcendent being in the centre of the *Iewel* by the 16. but becauſe the aſcendent is of a north ſigne in this natiuitie vz. the 5. of ♍ and the amplitude thereof by the 3. booke 20. Chapt. 16 $\frac{1}{2}$ deg. I reckon on thequinoct. which now repreſenteth the *Finitor*, the ſame 16 $\frac{1}{2}$ deg. and that from the centre rightwards towards noone, and there I conclude to be the eaſt point and that the 16 $\frac{1}{2}$ meridian is the aſt azimuth, and then if from this 16 $\frac{1}{2}$ meridian you reckon to the *Limbe*, and thenſe backe againe vntill your reckoning come to 90. the houreline there ending repreſenteth the meridian or ſouth azimuth, being here the 16 $\frac{1}{2}$ counted from the *Limbe* backe againe, ſo that hereby you may ground this generall rule, looke howe much the amplitude or eaſt point goeth rightwards from the centre, ſo much the meridian commeth backe from the *Limb* leftwards, and how much the amplitude goeth leftwardes ſo much the meridian commeth ſhort of the *Limbe* in reckoning, wherefore when you haue ſet thecliptick circle to the conſtitution of the 16. Chapter, and haue any planet or ſtarre propoſed, whoſe altitude and azimuth you deſire to knowe thereby, get his longitude and latitude in the zodiacke by an *Ephimeris* or other tables: reckon his longitude on this ecliptick circle being here the *Finitor*, and that from the centre or *Nonageſimus gradus* at the *Limbe*, as in the ſaid 54. Chapt. is ſhewed, and then on the azimuth there being, reckon his latit. by helpe of the almicantares, where you ſhal ſee the parallel reckoned from the equinoctiall ſhewing his altitude, and the houreline cutting there, reckoned from the point or houreline repreſenting the aſt azimuth found by the 16. Chapt. ſheweth the azimuth deſired.

Example. I ſhewed in my addition to the 33. Chapter of my 3. booke, the glorious planet Venus being the 10. of October 1580. in longitude 5. deg. 27. min. of ♎, in latitude 5. degrees ſouthwards, the ſunne then alſo being in ♎ 27. degrees 8. minutes that ſhe roſe about 6. minutes after 5. of the clocke in the morning. Nowe woulde I knowe what height ſhee was at 10. of the clocke the ſame morning and that by the rule of the 16. Chap. to ſee how it agreeth with the 3. booke 32. Chapter, firſt by the houre giuen videlicet 10. of the clock, and my addition to the thirde Booke 53. Chapter or the 11. of this booke, I get the *Nonageſimus gradus* to be 29 $\frac{1}{2}$ degrees of Leo and his altitude 46. degrees, therefore by the 16. Chapter I reckon 46. deg. on the *Limbe* from thequin. towards the north pole, thereto I place the *Finitor* with his almicant. downewards towards the ſouth pole, becauſe the latit. of ♀ was ſouth: the aſcendent then by the 3. booke 42. Chapter was ♏ 29 $\frac{1}{2}$ degrees, and his amplitude by the 3. booke 20. Chapt. 33 $\frac{1}{2}$ deg. which I reckon on the equinoctiall line from the centre leftwards, becauſe ♏ is a ſouth ſigne, and there is my eaſt point, and the 33 $\frac{1}{2}$ houreline cutting there, is my Eaſt azimuth. Well then becauſe in ſucceſſion of the ſignes after ♌ followeth ♍ ♎ &c. therefore ♌ being in the 90. degree, I know that Venus was then alſo in the eaſt quarter, that is to ſay eaſtwards of the 90. deg. For which cauſe I reckō on the *Finitor* from the *Limb* inwards, that is to ſay from the 90. deg. being ♌ 29 $\frac{1}{2}$ vntil I come vnto ♎, 5. deg. 27. min. & it endeth in the 37. deg. almoſt of the *Finitor* counted from the *Limb*, & on the azimuth there ſtanding, I reckon the lat. of ♀ vz. 5. where I ſee to cut the 31 $\frac{1}{2}$ parallel, whereby I conclude that ♀ was then ſo high, wheras if you had not reſpected the lat. but performed it by the long. after the 2. booke 54. Chap. that is to ſay, to haue taken the parallel cutting the *Finitor* it ſelfe in the 37. deg. from the *Limbe*, you ſhould haue founde ♀ 36. degrees heigh, which is no ſmall error if any man would thinke to know

know the houre not respecting the latitude. But nowe to know in what azimuth she was then in, from my East azimuth found as before, which is the $33\frac{1}{2}$ houreline leftwards of the centre, and there I number rightwards towards noone vntill I come to the houreline cutting the place or latitude of ♀ with the said $31\frac{1}{3}$ parallel and my reckoning commeth to $79\frac{1}{2}$. the azimuth desired, wherein Venus was that instant. And thus may you do for any fixed starre or other planet.

Chapter 18.

How by the constitution of the eclipticke as in the 16. Chapter to get the longitude and latitude of any starre or planet, that is to be seene in the skie, and thereby also his right ascension and declination.

GEmma Frisius as appeareth in my 3. Booke 39. Chapt. sheweth to get the longitude, and latitude of any starre or comet out of the heauens, as this Chapter doth purport, after another manner then heere shalbe shewed, but in my opinion not so exactly, yet with farre more trouble though both wayes do well to examine a truth one by another. Wherefore thus shal you do when you see any planet, starre, or comet, whose longitude and latitude you desire: gette his altitude and his azimuth by some instrument, and also the houre and minute by the 4. Chapter if it may be: these three must be had all at one instant, and that verie exactlie which done, by the houre had, set the *Finitor* to the constitution of the 16. Chapter, and then by the East point founde by the saide 16. or 17. Chapter, seeke out the houreline representing the azimuth as there also is shewed, whereon reckon so many degrees from the equinoctiall line as the planet or starres altitude taken come to, and the azimuth and almicantare cutting there, sheweth the longitude and latitude desired accounting them as in the 16. and 17. Chap. is shewed.

Example. Of ♀ in the last Chapt. Admitte I had taken her azimuth $79\frac{1}{2}$ and her altitude $31\frac{1}{3}$ at tenne of the clocke in the morning the seconde of Ianuarie 1579. I being nowe in Gloster shire in the Christmasse time with the good knight and my deare vncle Syr Iohn Hungerforde, who departed this worlde the 19. of March, Anno 1582. there chaunced a great snow a day or two before, and therewithall followed rimie dayes, by which meanes although there were no cloudes to be seene in the whole skie, yet by reason of the rimie thinne vapours that did hang in the lower region of the aire that much brake the force of the sunne beames, I did perceiue the sunne, the moone, and Venus who then was betweene the ☉ and ☾, all three of them at two of the clocke in the afternoone the same day: or rather somwhat before, and so all the day after, which I shewed there to diuerse of my friends and kinsmen which were there as I was, to passe the time with that worshipfull knight, whose hospitalitie was most bountifull. Wherefore admitte the tenth of October 1580. were some such like day, if you will graunt no absurditie, and that then I had taken the altitude of ♀ $31\frac{1}{3}$ deg. and her azimuth $79\frac{1}{2}$ at 10. of the clocke shee being to fight Eastwards of the *Nonagesimus gradus* and woulde thereby knowe her longitude and latitude, which to doe, I lay the degree of ☉ videlicet ♎ 27. degrees 8. minutes vnto 10. of the clocke in the *Limbe*, where I finde the ascendent ♏ $29\frac{1}{2}$, his amplitude $33\frac{1}{2}$, the *Nonagesimus gradus* ♌ $29\frac{1}{2}$, his altitude 46. by which I set the *Finitor* to the constitution of the 16. Chapter in all respectes as is done in the last Chapter, then by reckoning the amplitude of the ascendent videlicet $33\frac{1}{2}$ on the Equinoctiall line leftwards from the centre, because the ascendent was a south signe: there I finde the East point, from which towards the south I reckon among the houreline, the azimuth of ♀ videlicet $79\frac{1}{2}$ which lighteth out in the 46. meridian counted from the *Limbe*, in which 46. houreline, I reckon from the Equinoctiall line the altitude of ♀ vid. $39\frac{1}{3}$ which if your almicantares chance to be turned towards the North pole, you shall perceiue not to reach the eclipticke or *Finitor*: and therefore turne about the *Reete* that the almicantares may stande downewards towards the south pole, and then doth the said $31\frac{1}{3}$ deg. of the 46 meridian cutte the 5. almicantare, which sheweth that ♀ was then 5. degrees in latitude, and also it cutteth the 37. azimuth which followed to the *Finitor*, shewing her longitude if you account from the *Limbe* or 90. degree thither, that is to say, because ♀ was in the west quarter: therefore the rediest way is according to the sequele of the signes count it from the end of the *Finitor* at the *Limbe* being ♌ $29\frac{1}{2}$, thence numbring downe towardes the ascendent at the centre vnto the said 37. azimuth, it will fall out to be the $5\frac{1}{2}$ of ♎, the longitude of Venus. And thus may you doe with any fixed starre or other planet, the Moone excepted, whose parallexis maketh many alterations in this behalfe.

Chapter 19.

The altitude and azimuth of the sunne, or any planet or starre giuen, how by the constitution of the 16. Chapter, to get their exact longitude.

THe sunne neuer hath latitude, and therefore we shall soone dispatch with him, the latitude of any other planet or starres, you must get by tables, as in the eight Chapter you did, which had, get at any instant the azimuth of the planet or starre exactly by some large instrument, either by the third booke 35. Chap. or by this next Chapter following, and the houre and minute at the same instant, by which set the *Finitor* in the constitution of the 16. Chapter with his almicantares to the North pole, if the latitude of the same planet

or ſtarre be North or to the South pole,if South, then by the 16.or 17. finde out the houre line repreſenting the azimuth ſo taken,and mark where the ſame houre line cutteth the almicantare repreſenting the planet or ſtarres latitude,and there ſhal you ſee the azimuth crosſing, pointing on the *Finitor* the deg.of the longitude ſought for, if you reckon the ſame from the centre or deſcendent,the planet or ſtarre being on the VVeſt quarter,or from the *Limbe* or *nonageſ.grad.* if on the Eaſt as in the ſixteene.and 17. chapter, is ſhewed: as in my former example of *Venus*,admit that the ſaid 10.of October 1580. I found by the Ephemeris her latitude 5. deg.Southwards,and that the ſame day at 10.a clocke I took her azimuth $79\frac{1}{2}$.deg.from the Eaſt by a large inſtrumēt, then by the 16.chap.I ſet my *Iewell* to the conſtitution of the Eclipticke with the almicantares towardes the South pole,becauſe the latitude was South: which done, according as is ſhewed in the ſame 17. chap.I found the 46.houre line counted from the *Limbe* to repreſent the $33\frac{1}{2}$.azimuth: and now whereas this 46.houre line cutteth the 5.almicantare,there doe I ſee the 73.azimuth reckoned from the *Limbe*, to croſſe, whoſe degree reckoned on the *Finitor* from the *Limbe* or 90.degree,bicauſe that *Venus* was on the Eaſt quarter, falleth out to be the 5.deg.$\frac{1}{2}$.of ♎. which I conclude to be the longitude of ♀ at that inſtaunt.Hereby maye any man rectify the places of the fyxed ſtarres very eaſily,becauſe their latitudes neuer alter, and their azymuthes are eaſily taken at all times.

Chapter 20.

How to get the true and exact azimuth of any planet,comet,or ſtarre vnknowne.

YOu ſhall at one inſtaunt take the altitude as well of the planet or comet,whoſe azimuth you ſeek,as alſo of ſome one knowne ſtarre, not farre diſtaunt from him,which noted, you ſhall by helpe of your *Iewell*,or els of the croſſe ſtaffe,take the diſtaunce between this knowne ſtarre and the ſame planet:whiche noted, alſo you ſhal then reckon on the *Limbe* of your *Iewell* from the Equinoctiāl line towardes the pole, the greateſt altitude before taken,whereto ſet the Zenith point of the *Reete* fyxed, and among the parallelles counted from the Equinoctiall towardes the ſame pole,count the leſſer altitude : then among the almicantares counted from the Zenith poynt,reckon the ſaide diſtaunce taken : now where this almicantare and the ſaide parallel do croſſe,the meridian of the *Mater* cutting there,counted from the *Limbe*, ſheweth the horizontall diſtance betweene the ſayde knowne ſtarres azimuth,and the azimuth wherein the ſaid comet or planet was at the taking of the altitudes,which azimuthal diſtance or difference, you may adde or ſubtract too or from the ſtarres ſaide azimuth according to the coaſt,which you ſhall ſee one of them to ſtande from other in the skye. I truſt you can not be to ſeeke of the ſtarres azimuth, except you forgette the third booke 27. and 33.chap.

This working differeth little from the 8.chap.and therefore needeth no example,for here by the two altitudes and diſtaunce you get the difference of the azimuthes as there by the two latitudes and diſtance you got the difference of longitudes.But here alſo in the moone her parallaxis will make you miſſe certaine min. which in my booke of longitudes,I wil teach you to remedy.

Chapter 21.

The moone ſhining on any ſun diall to know in the night, what it is a clocke,very ſpeedily by helpe of the Iewell.

MArke what houre and part the ſhade of the moone giueth in the diall,then goe to an ordinary Almanacke,& looke in what ſigne and deg.the moon then is,lay the ſame deg.of the Zodiack by help of the *Label* to the like houre,& part on the *Limbe* of the *Iewel*,which the ſhade of the diall gaue you: and thence remouing the *Label* to the deg.of the ſun,it ſheweth you the houre & time ſought for : and that very eaſily without taking the moones altitude,or other troubleſome working,as in the 3.booke 27.chap. is required.But by the way you muſt not forget firſt to rectify the moones place by adding or ſubducting one deg.for euery houre,that you imagine the time propoſed to be diſtant from noone, as I haue often warned you.

Chapter 22.

A ſpeedy way to know what it is a clocke by the ſtarres without taking their altitude.

VVHen you go forth any night,firſt behold the North pole,& therby directly back oppoſite therto,you ſhal eaſily fynd the ſouth: then mark whether you ſee any notable ſtarre there placed at that inſtāt: if any ſuch ſo chaunce,and that the ſame ſtarre be on your *Reete*,laye his apex on the noone lyne of your *Iewell* towards Meridies,and placing then the *Label* on the deg.of the ſunne,it ſheweth in the *Limbe* the houre deſired.

The like may you doe with any ſtarre,you ſhall chaunce to ſee on the North part of the meridian by laying his apex on the noone line towards *Mediam nox.*

Alſo you may with a little exerciſe iudge by ſight very neere how many houres anye ſtarre that you ſee in the skie lacketh of,or is paſt the South,if the ſcantlet be not ouer great,whereby laying his apex by helpe of the *Labell*,to ſo many houres of the *Limbe*,wanting or paſt the noone line, then *locus ſolis oſtendit horam.* Truely this Chap.beſides the eaſe and ſpeede that it hath,giueth a great deale more credit among the vnlearned, then the other way,for they murmure if one be long hunting after the houre,and thinke the deuiſe of ſmal repu

tation not respecting art. It needeth no example.

Chapter 23.

The vse of the three tables comprehended in the 2. figure of the second booke 13. Chap.

I Thinke it not amisse here to shew the vse of the saide 3. tables to fyt the fancy of some men which may delight therein. First therfore you must remember that the whole rundle containeth 6. spaces, one compassing in another: of which 6. spaces, in the three vttermost are contained 2. seueral tables: the first seruing to get the dominical letter, the 2. the prime and Epact for euer. And in the 3. innermost of the same 6. spaces is onely contained the third table seruing to get Easter day for euer.

By the first table to get the Dominical letter for euer.

SEeke the yeere proposed in his vttermost space, and directly vnder it in the third space, you haue there the Dominicall letter, but if it be leape yeere, then is the letter in the middle space your desire: and when this table is worne out, you may begin his date againe where you left, that is to say, where 1582. is, there set 1610. at 1583, set 1611. & so forth, to be continued vnto the worlds end.

By the 2. table to get the Prime and Epact for euer.

SEeke the yeere proposed in the second table, and directly vnder it in the second space is the prime, and in the 3. space the Epact answearable to that yeere, this table you may also beginne againe like the former & so continue him for euer.

By the third table to finde Easter day for euer.

FIrst learne the Dominicall letter of your yeere proposed by the first table: and by the second the prime of the same yeere, these had, seeke the said prime number, in the vttermost space of the 3. table, and in the middlemost space seeke the sayde dominicall letter next vnto the prime rightwards from it in numbring, and there in the 3. space you shall finde directly vnder that letter, what day Easter day shall fal on that yeere.

Example of all three tables.

THis yeere 1584. I would know the Dominicall letter, the Prime, Epact, and Easter day, I seek the sayd yeere, videl. 1584. in the first table vnder it I fynde E the Dominicall letter, becausse it is Leape yeere: then in the 2. table I seeke the yeere 1584. there I finde vnder it the Prime to be 8, the Epact 24. Lastly, in the vtter row of the 3. table I seeke the prime of this yeere 1584. videl. 8. vnder which in the middle rowe is the letter C, but reckoning on in order rightwards till I fynd my Dominicall letter E, vnder it in the innermost space I see 20. and becausse this worde Aprill went last before in the same space, I conclude the 20. of Aprill to be Easter day.

The conclusion of this fourth Booke.

MY leisure on the one side not seruing me to beate about ordinary propositions, and finding on the other side my *Iewel* to cal me away vnto such more effectual matters, which rather require seueral treatises, as in my 5. and 6. bookes. and also in other 6. bookes (which after these if God spare me life and leisure, I meane shortly to set forth) shal appeare. I here therefore conclude this 4. booke of mine, least by seeking to enlarge it, I should cõfusedly place many things as I once had done. For I haue taken out diuers chapters about the Moones parallax, and other matters: reseruing them as more fit for my booke of longitudes and other like places: and were it that I had conuenient leisure to translate and alter the whole worke, this 4. booke should not be at all, but be disseuered into the rest of the 12. bookes, neither should some part of the est goe forth as it doeth, but that of necessitie for want of leisure I am forced to let it passe, hoping that little bias wil be borne withal, meaning to amend in the next.

The fifth book of the Mathematicall *Iewell*, newly inuented, compiled and set forth *by* Iohn Blagraue *of Reading, Gentleman: teaching most* plainely to performe on the Iewell the whole art of sphericall triangles, without any whit of that great toyle by synes supplementes, tables, proportions, Arithmeticall calculations, *and such like: by which Ptolomeus, Regimontan. Copernicus, and* all other Authors before me, haue wrought them, here pefourmed by ocular inspection with surpassing facility, and maye bee called the key of the knowledge of the sphere, in that it vnlocketh all spherical questions whatsoeuer: and is a singuler introduction vnto the Sinicall woorking.

Chapter 1.

Of the Exposition of a Sinicall quadrant, and all thinges thereto appertayning.

A Quadrant is in briefe the quarter of a circle, encluded with two semidiameters, as you see here this figure A B C. The arch thereof, vz. B C, I call the *Limbe* which is deuided as the order is, into 90. degr. The semidiameter erected, vz. B A is the side of the quadrant, the other semidiameter, vz. A C is the groundline or base of the quadrant, from which the *Limbe* beginneth to be numbred, vz. from C towards B. The Limbe.

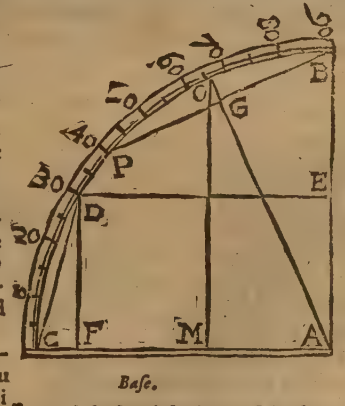
An arch in Latine *Arcus*, is any porcion of the circumference or rynge of a circle, as here, B O, O P, P D, B C, &c. The arche.

A Chorde in Latine *Chorda*, is as it were the diameter to the arche, or the string to the bow, as here the streight line B G P, is the chorde of the arch B O P, and the line D C of the arche D C. Chorde.

The Complement of an arch in Latine *Complementum arcus*, is that portion of a circle, which any arch lacketh of a quadrant or 90. degrees, as the complement of the arch B D is the arch D C, and the complemē- of D C, is B D. So that alwayes the arche and his complement make a quadrant. Complement.

A Syne in Latine *Sinus*, is a streight line commensurable yether in length or power vnto the diameter of a circle, and to be measured by his parts. A Sine.

The Syne totall in Latine *Sinus totus*, is the side or base of the quadrant, as A B, or A C, deuided into an 100. equall parts at the least, but rather into a 1000. 10000. or 100000. parts for the more the better. Sine totall.



A right Syne in Latine *Sinus rectus*, is anye perpendicular falling from the arch or *Limbe* of the quadrant on his base, as here you see D F is the right Syne of the arch D C, and O M of O C, and is denominated of those parts of the Syne total, whiche he contayneth or more briefly a right Syne is halfe the cord of any arch doubled, as the right Syne of B O is the line B G. Right Sine.

A backe Syne in Latine *Sinus versus*, is any perpendicular falling from the arch or *Limbe* of the quadrant on his side, as you see D E, which is called the backe sine of the arch D C. By thi you may see and learne if you marke it, that the backe Syne of any arch, is the right Syne of the same arches complement, for D E is the backe Syne of the arch D C, but it is the right Syne of B D. VVherefore in briefe, a backe Syne is halfe the chorde of the arches complement doubled. Sinus versus.

The Supplement of a Syne is that which any Syne lacketh of the quadrantes side or Syne totall, as B E is the supplement of the right Syne F D, or A E, which is equall vnto it: likewise F C is the supplement of the backe Syne E D, for E D and F C make the Syne totall. Supplement of a Sine.

Note that some Authors make but three distinctions of Synes, as I haue here done, vz. *totus rectus & versus*. Other some as namely *Apian* and *Munster* make foure, vz. *Sinus totus*, then *Sinus rectus primus*, which here I call the right Syne, and *Sinus rectus secundus*, which I call the backe Syne, and then *Sinus versus* to be that which I call the Supplement of the backe Syne, videl. F C, being as the arrow to the bow: but truely I like not thereof, and therefore I haue thought good to call both F C and E B Supplementes as before, for if so be that F C be *Sinus versus*, then may E B be as wel *Sinus versus secundus*. The matter is not great for the names, so you vnderstand the mea-

meaning, for I ſhall neede none of them all in this my woorke of tryangles. Therefore I will not ſtriue, yet I thought good here to ſet theſe downe, leaſt happily their names come in queſtion vnwares to the amazemẽt of ſome young beginner, as ſometime it happened to me: for *Ignoratis terminis, ignoratur & ars.*

Note further, that in all the Figures of this woorke of tryangles all ſtreight lynes cutting the Centre of any circle, and al arches howſoeuer they be drawne, are to be taken for great circles or portions of them, that is to ſay of circles of one ſelfeſame quantity, and of one ſelfeſame quantity, and of one ſelfeſame ſpheare.

Chapter 2

Of certayne definitions needfull to the vnderſtanding of this woorke.

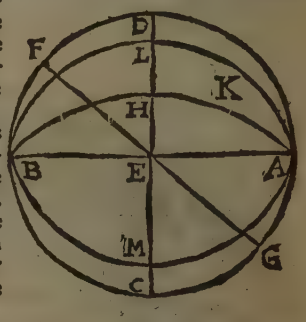
Great circles.

VVHat a ſpheare or globe is with hys axetree and poles, is ſhewed in the 1. booke 3. chap.

1 Great circles of the ſpheare or of any ſpherical body, are thoſe whoſe diameters are equall to the ſpheares diameter concentricke to the ſpheare, and are ech deuyded by ſuppoſition into 360. equall and lyke partes or degrees, ſuche are the Equinoctiall, the Eclipticke, and all the Meridians or any other circle imagyned on the ſpheare, equall to any of them. As for example, in the ſpheare A B, C D, all the cyrcles A E B, D E C, F E G, and A L, B M, are equall, E beyng centre to them all, and to the ſpheare it ſelfe.

Though the ſpheare hath properly but one axetree and two poles in reſpect of his dayly motion: yet muſt it be here graunted that euerye great circle of the ſpeare whatſoeuer, hath his peculiar axetree and poles, though no motion on them performed: the axetree of a great circle is a dimetient or diametre of the ſpheare, drawen perpendiculer to the flat of the ſame great circle through hys centre, as the line A E B, is the axetree of the circle D E C: and ſo of the reſt. But this kinde of axetree line ſeldom commeth in queſtion only his extreames, which are called the poles of the ſame circle, are in this treatiſe altogether vſed and are thus defyned.

Axis.



Poles.

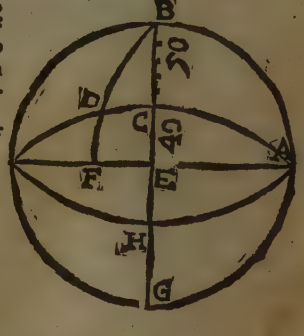
2 *I. Regio. lib. 4. cap. 2.* The poles of euery great circle are 2. oppoſite points eche of them diſtaunt from euery part of his circumference, nienety degrees or a quarter of a circle, as the pointes A and B are the poles of the circle D E C, and are diſtant 90. deg. from euery of the poynts D L H E M C, of the ſame circle. Likewiſe the poyntes D and C are the poles of the circle A E B, and the poles of the circle A B C D, doe lye both couched in the point or centre E, which of neceſsitie is 90. degr. diſtaunt from euery part of the circle A B C D; briefly the pole of any circle is the poynt of the ſpheare, from whence as a centre, the ſame circle is deſcribed.

Perpendiculer archa.

3 *Io. Regio. lib. 4. cap. 1.* A perpendiculer arch to any great circle is a portion of a great circle paſſing by the poles of the great circle whereon it falleth, or at the leaſt ſuch a portion as will paſſe by, or cut his poles, if he be drawne forth, as in the ſpheare A B C D, the arch K H, is perpendiculer to the circle D E C, becauſe if it were drawn forth, it wil cut his poles A and B. Likewiſe B D, B H, B E, & B C, are perpendiculer arches vnto D E C, becauſe they all yſſue from the pole of D E C, vz. B, and ſo are E D, E A, E B, E C, E F, and E G, perpendiculer arches to the circle A B, C D, by the ſame reaſon: and ſo of the reſt.

Sphericall angles.

4 A ſphericall angle, is an angle included by the touching or croſſing of two great circles or their arches and is denominated by the baſe of the angle at 90. deg. from the croſsing as in the ſpheare A B G, the 2. arches A B, & A D, do include a ſpherical angle denominated by the arch B C, which arch B C is in euery 90. degr. from A. So that if the arch B C, containe 50. degr. then is the angle B A D ſo much: likewiſe the arches B D, and B C, doe include an angle, whoſe denomination is E F. But to define it more artificially, a ſphericall angle is an angle contained between two great circles, and denominated by that portion of the greate circle, deſcribed on the point of their croſsing, which is included betweene them.



Sphericall triangle.

5 A Sphericall triangle is a ſpherical flat, included by three arches of great circles, as A B D, is a ſpherical tryangle included by the three arches A B, B D, and D A: likewiſe A B D, and B C D, and D A F, are ſpherical triangles, and ſo of the reſt.

right angled Sphericall triangle.

6 A right angled ſpherical triangle is, that hath one right angle, or more, as A B C, is a right angled tryangle, whoſe angles B and C, are both right angles by the thirde definition, becauſe A B and A C, ſtande perpendicular on B C. Alſo A B E, is a triangle of three right angles, and B C D, is a tryangle of one right angle vz. C. becauſe the arch D C, ſtandeth perpendicular on B C, by the 3. diff.

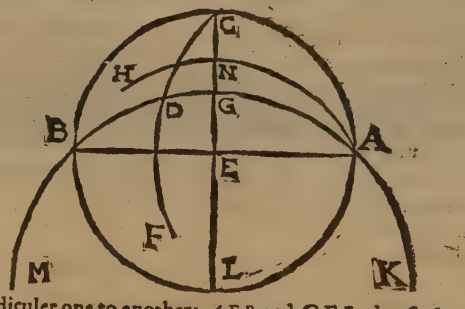
7 Equall ſpherical angles are thoſe whoſe denominations are equall, being in equal ſpheres.

8 In euery ſpherical triangle, the ſide lying againſt any angle, is called the ſide, ſubtending the ſame angle, the other two ſides are called the ſides including the ſame angle.

Chap. 3.

Of cereaine Theoremes needeful to be premiſed for the better vnderſtanding of this my preſent worke of Spherical triangles.

Io. Reg. lib. 3. cap. 19. ALl great circles of the ſphere, howſoeuer they be drawne, deuide eche other in halfe which is thus proued. Any two great circles being drawne on a ſphere howeſoeuer ſhall both bee concentricke to the ſphere by the firſt definition, and therefore of neceſsitye concentricke one to another: (that is to ſay) made both vpon one centre, euen the centre of the ſphere: wherefore they muſt needes croſſe one another on the extreames of a diametre of the ſphere. Now ſince by the 9. Geometrical definition of the fyrſt booke, a diameter cutteth alwaies any cyrcle in halfe, therefore of neceſsity anye two circles croſsing on another on the extreames of a lyne being diameter to them both, muſt needes deuyde eche other in halfe, ſince the ſame diameter deuideth them both in halfe. So is it with al the great circles of any ſpheare, for a line drawne betweene both croſſing of anye twoo circles, cutteth alwaies the centre of the Sphere, and is diameter to them both moſt manifeſtly as in this ſphere, A L B C, the great circles A C B, & *A G B*, deuide eche other in halfe on the diameter *A B*. Marke this Theoreme well, for hee often commeth in queſtion.



2 If two greate cyrcles or arches of great circles croſſe eche other, the two poyntes of theyr circumferences furtheſt diſtaunt, ſhall bee in eche circle at nientie degrees from the croſsing, this is manifeſt by the fourth diff. as in this ſphere *A L, B C*, the twoo arches A D, and A H, croſsing in A, I ſay that they ſhal be farthest inſunder in N and G, both which are 90. deg. diſtant from A by the ſaid 4. diff.

3 *Io. Regi. lib. 3. cap. 17. 18. 20.* If 2. great circles croſsing one another, doe cut ech others poles, they make at eche croſsing 4. right angles. This is moſt manifeſt by the 3. diff. becauſe they then muſt needs ſtand perpendiculer one to another: *A E B*, and C E L, doe ſo deuide themſelues.

4 Any two great circles of the ſphere, howſoeuer they croſſe, make at ech point of croſsing foure angles equall vnto foure right angles, the reaſon is this: looke what the one angle lacketh of a right angle, the other hath it euen as it is in ſtreight lynes croſsing eche other by the firſt booke 15. propo. of *Euclide*, as at the two pointes of croſſing *A B* of the two great circles K A, *B M*, and C A, *L B*: at the one, videl. A, the angles C A G, G A L, C A K, and K A L, are equall to foure right angles, for as C A G, and K A L, are eche leſſe then a right angle, ſo C A K, and G A L, are ech greater by ſo much, as one of the other want: likewiſe is it of the 4. angles *C B G, G B L, L B M*, and *M B C*, at the croſsing *B*.

5 Of euery two great circles croſsing ech other, the two oppoſite angles at ech croſsing, are equall, as the two great circles *A C B*, and *K A G B*, croſsing *M A* and *B*, I ſay that at the croſsing A, the angle *C A K* is equall to the oppoſite angle K A L: and C A K, equall to *B A L*. The proofe heereof differeth not from the ſayde firſt booke fyfteene propoſ. of *Euclide*, and therefore any one of the foure angles knowne, take him out of the ſemicircle, videl. 180. degrees, he leaueth the other knowne. As for example, if the angle *C A B*, be 50. deg. take that out of 180. it leaueth 130. deg. the quantity of the angle *B A L*, and ſo much is the angle C A K alſo by this Theoreme.

6 All great circles or arches of great circles drawne forth, being perpendiculer to anye one greate circle, muſt needs meet and croſſe at his poles: this is manifeſt inough by the 3. defynition, for otherwiſe they could not bee perpendiculer.

7 Two ſemicircles, or equal arches can include no triangle; for then were it repugnant to the defynition of a triangle, which muſt haue 3. ſides.

8 *I. Regiom. lib. 3. cap. 37. 38.* In euery tryangle any two ſides muſt needes be longer then the third, for if two ſides ſhould be equall to the third, then ioyned together, they make an arch equall to the thirde ſide, and then can they not include a tryangle by the 7. theoreme: if ſhorter, then could they neuer reach the third ſide, thys is demonſtrated in the 1. booke 20. propoſ. of *Euclide*.

9 *Coper. 2. trian. ſph.* Euery of the ſides of a ſphericall triangle, muſt needs be leſſe thē a Semicircle: for if you admit one ſide of a triangle to be a Semicircle, as A L B, then cannot the other two be leſſe then ech of them a quadrant, becauſe they cannot els reach home, if ſo as A G, and B G, or A C, and B C, you ſee that at theyr meeting G or C, they become a ſemicircle, as A G B, or A C B, and then by the ſeuenth theoreme can include no triangle. If you would imagine the other two ſides greater then 2. quadrants, then would they meet without the ſpheare, and there can make no ſpherical triangle by the 5. definition.

10 *Ioh. Regiomont. lib. 3. cap. 39.* The three ſides of euery ſpherical tryangle muſt needes bee leſſe then twoo ſemicircles, this is ſufficiently proued by the nienth theoreme. For otherwiſe they muſt needes meete wythout the ſpheare in an irreguler forme, or within the ſpheare like the three ſides A L, B C, with C D, and A D: which 3. you ſee make no trianguler forme.

11 *Ioh. Regiomont. lib. 3. cap. 49.* It is demonſtrated in the 1. book 32. propoſ. of *Euclide*, that in euery right lined tryangle, the three angles are alwayes equall vnto twoo right angles. But in all ſphericall tryangles, the three angles are alwayes greater then twoo righte angles, as by the ſixte definition partely appeareth

How

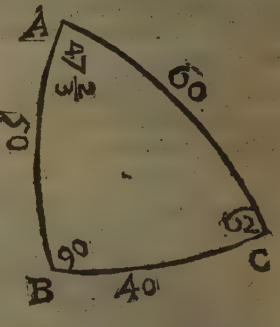
12 How many great circles soeuer crosse in one point of the spheare, euery of their poles are to be found in that great circle, vnto which that poynt of crosing is pole: for example of the circles, C A N A G A E A & L A. I say that euery of their poles lyeth in the circle C E L, vnto which the point A is pole by the seconde diff. This is most manifest, for by the 3. diff. the pole or poles of any circle must needes be found in another circle, standing perpendiculer thereon: and seeing by the 3. and 6. theoreme, all those circles are perpendiculer to C E L, and C E L perpendiculer to them, therefore by the 2. and 3. diff. all their poles must needes lye in C E L.

These definitions and Theoremes premised, shalbe inough for my purpose.

Chapter 4.

If of a right angled spherical triangle, two sides shalbe knowne how to get the quantity of the third side, and the other two angles.

A Right angle as well spherical as playne, contayneth 90. degrees: wherefore he is alwayes knowen. Lette there be proposed the right angled triangle A B C, whose two sides A B and C B contayning the right angle B, let them be giuen, vz. A B, 50. deg. and B C 40. deg. Now wil I shew you by the *Iewel* to get the quantity of the third side C A, and of the angles A and C beeyng yet vnknowne.



Number on the Equinoctial line of your *Iewell* from the centre outwards the quantity of the side A B geuen, videl. 50. deg. then on the meridiã meeting there, being the 50. meridian counted from the centre, reckon from the Equinoctiall towards the pole, the side B C giuen, videlicet 40. degrees, therto lay the rule, and note the degrees thereof cut, counted from the centre, by the saide 40. degree of the said 50. meridian, which you shall finde $60\frac{1}{3}$. deg. the same is the quantity of the third side sought for, videl. A C, and that which more is, there doe you see your whole triangle on the *Iewell*, as plainly as on any spheare, included by those three arches, videl. $60\frac{1}{3}$. of the rule, 50 deg. of the Equinoctiall, and 40. deg. of the said 50. meridian, which being well marked and vnderstood of you, then following the *Label* to the *Limbe*, it cutteth there also $47\frac{2}{3}$. deg. which must needes bee the quantity of the angle A by the 4. difference, being that the side B C videlicet 40. degrees subtendeth it, and thus haue we one of the angles sought for, the other you shall thus easilye finde.

Reckon the side B C videlicet 40. degrees on the Equinoctial from the centre, then on the 40. meridian there, reckon the side A B, subtending the angle wanting, videl. 50. deg. thereto lay the *Label*, and you shal see $60\frac{1}{3}$. deg. thereof cut as before: the *Label* cutting in the *Limbe* 62. degr. whiche is the quantity of C, the other angle sought for. Hereby you may perceiue of your selfe, that it is no matter with which of the two sides gyuen, you begin in performing this chap.

But you will say what if the side A C. videlicet $60\frac{1}{3}$. deg. subtending the right angle B with one of his including sides as the side B C, be giuen, A B being vnknowen. Here must you begin on the *Label*, and reckon theron from the centre, the subtending side A C, videl. $60\frac{1}{3}$. then mouing vp and down the rule, til the same $60\frac{1}{3}$. degree, doe cut among the parallels the degree of the side B C geuen, vz. the 40. parallell counted from the Equinoctiall, where you shall finde to meete you the 50. meridian as before is sayde to make vp your tryangle.

In briefe.

If the two sides including the right angle be giuen, reckon the one on the Equinoctiall outwards from the centre: and thence in the meridian there, reckon the other vpwards: thereto laying the rule, whose degr. cut, counted from the centre, is the third side: and it sheweth in the *Limbe* one of the angles sought: but if the subtending side with one of the including sides be giuen, reckon the subtending side first on the rule from the centre outwards, and lay that degree on the parallel aunswearable to the other side giuen: and there shall meet you the meridian that maketh vp the tryangle, the rule shewing as before, one of the angles at the *Limbe*.

Chapter 5.

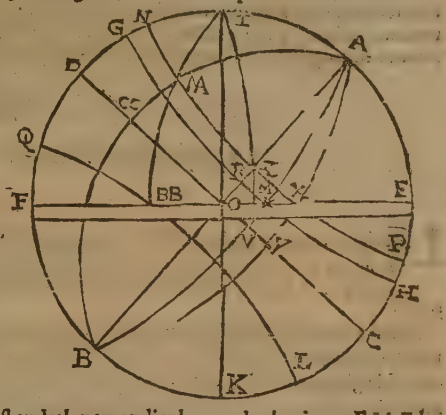
The declination of the Sunne, Moone, or any other planet or starre from the Equinoctial, giuen together with the Latitude of the countrey, how by the 4. chap. to get the amplitude, the difference of ascension, the oblique ascension, and the diurnal arch of any of them.

Here shall you partly perceiue a tast of the great fruite that commeth since of one chapt. of spherical tryangles, which extendeth it selfe to infinite questions, therefore it is no maruel, that so many greate volumes haue bin written of them.

I wil take now for example the great starre of the first light, called *Oculus tauri*, the bulles eye: his declynation I finde after *Stadius* in the table of starres in my 2. booke, to be $15\frac{42}{60}$. degr. Northwardes, which in thys

presens

preſent figure is the ſpace, G D or M whiche is equal to it, the height of the North pole aboue the horizon being the ſpace E A, which is 51 $\frac{2}{3}$. deg. here at Reading: theſe two giuen, I wil, I ſay, perform all the premiſſes: and thus I goe to worke. The circle H G is the 15 $\frac{49}{60}$. parallel of declination Northwards, in which the ſtarre is fixed, I ſay fyxed, not exempting his diurnal motion, mentioned in the 1. booke and 9. chap. *ex raptu primi mobilis*, wherefore at his riſing hee muſt needes cut the point M of the horizon E F, the ſpace M O being his amplitude of riſing in this countrey, which to fynd, I ſubduct the declination of the ſtarre 15 $\frac{49}{60}$. deg. videl. M V out of 90. vid. A V, there reſteth his complement of declination 74 $\frac{11}{60}$. deg. videl. A M. And ſo haue you two ſides of the right angled ſpherical triangle A E M, giuen v. A M 74 $\frac{11}{60}$. and A E 51 $\frac{2}{3}$. deg. V V herefore by the 4. chap. you now gette the thirde ſide, E M, 63 $\frac{1}{2}$. deg. the complement whereof, v. M O, being 26 $\frac{1}{2}$. deg. is the amplitude ſought for. That A E M is a right angled triangle is manifeſt, for that the arch A E ſtandeth perpendiculer on the horizon E M F, by the third def. in reſpect that being drawne foorth, it cutteth the pole of the horizon E M F, videl. the Zenith point 1.



Then for the difference of aſcenſion and the oblique aſcenſion learne by the fourth chap. likewiſe the quãtity of the angle E A M being an angle of the ſame triangle, which by the 4. def. is denominated by the arch of the Equinoctial C V, videl. 69. deg. whoſe complement videl. V O is 21. degr. which by the 3. booke 13. chap. muſt needes be his difference of aſcenſion, and is the quantity of the angle M A O. This arch V O, videl. 21. ſubduct from his right aſcenſion, which by the 3. booke 17. chap. is 62 $\frac{1}{2}$. deg. there reſteth 41 $\frac{1}{2}$. degr. his oblique aſcenſion being a North ſtarre, but if it had bin a South ſtarre, you ſhould haue added this arch by the third booke 15. and 17. chap.

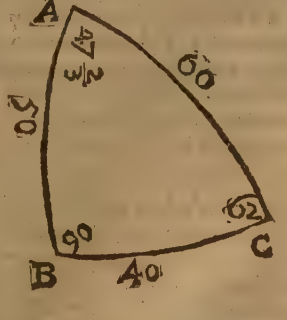
Laſtly, for his diurnall arche, adde the arch V O, videl. 21. vnto the quadrant O D, vz. 90. thereof commeth 111. the arch V D, or rather M G, his ſemidiurnall arch: that doubled, maketh 222. his diurnall arch, which 222. deg. deuided by 15. deg. leaueth in the quotient 14 $\frac{11}{15}$. houres: or more playne 14. houres 3. quarters and more: ſo long doth *Oculus tauri* bide aboue our Horizon betweene his riſing and ſetting. Note that in the ſun this Semidiurnall arche deuided by 15. ſheweth the houres of his riſing and ſetting counted from noone.

Chapter 6.

To perfourme the 4. chap. on the Iewell *by another manner of woorking.*

FOr this purpoſe let the right angled triangle in the 4. chap. be propoſed againe, whoſe ſide A C ſubtending the right angle B, let bee giuen: vz. 60 $\frac{1}{3}$. deg. and the ſide C B, vz. 40. deg. being one of the including ſides. Now to find the other ſide and angles after another manner, then in the 4. chap. is ſhewed, doe thus.

The Zenith line of your *Rete*, firſt placed euen in the Equinoctial line, and there fixed: ſeeke the length of the ſubtending ſide giuen, A B, videl. 63 $\frac{1}{3}$. deg. among the almicantares counted from the zenith poynt, and the length of the other ſide giuen, C B videl. 40. deg. amongſt the parallels of the *Mater*. counted from the Equinoctiall: in the croſsing of thys 60 $\frac{1}{3}$. almicantare, and 40. parallel, you ſhall finde the 50. meridian to cut and alſo the 42 $\frac{1}{3}$. azimuth: both counted from the *Limbe*, which two with the portion of the Equinoctiall or zenith line lying betweene them, doe ſhew the three ſides of the triangle ſought for in their right conſtitution. The ſaide 50. meridian cutteth in the zenith line which now lyeth euen in the Equinoctiall 50. deg. for the ſide A B, and in the ſaide 42 $\frac{1}{3}$. azim. 60 $\frac{1}{3}$. deg. for the ſide A C, both counted from the zenith poynt: and the ſame 42 $\frac{1}{3}$. azimuth, cutteth 40. deg. of the ſame 50. meridian counted frõ the Equinoctial for the ſide B C. Beſides all this, if you follow the 42 $\frac{1}{3}$. azimuth to the *Finitor* line, he there cutteth off 47 $\frac{2}{3}$. degrees, counted from the centre, the angle ſubtended by the ſide B C, videlicet, the angle A, by the fourth def. euen as it was founde by the 4. chapt. But now for the thirde angle videl. C, you muſt ſhift the ſides thus. The Zenith line lying ſtil in the Equinoctiall, reckon thereon from the Zenith point, the ſide B C, videl. 40. deg. there cutteth the 40. meridian, vpon which reckon the quantity of the ſide ſubtending the angle you ſeek, videl. A B, 50. degrees, and there ſhall you ſee to cutte the 28. azimuth counted from the *Limbe*, which followed to the *Finitor*, ſheweth 62. deg. counted from the centre, euen as in the 4. chap. the quantity of the angle C by the 4. def.



But

But here you will say: what if the two sides including the right angle be giuen, I aunsweare, there is no difference in the working to finde the subtending side from that which I did last to fynd the third angle: for the one including side reckoned on the Zenith, the other on the meridian, there standing, you shall see the azimuth cutting there that meridian to make vp the third side.

Chapter 7.

To perfourme the same by the Iewell *after a thirde manner.*

LEt the former triangle A B C remaine, whose side subtending the right angle, videl. A C, $63\frac{1}{3}$. degr. and the side A B videl. 50. deg. one of the including sides let be knowne, the thyrde B C vnknowne, wyth the angles A and C, which three after another manner then yet hath beene shewed, I will teache you to fynde.

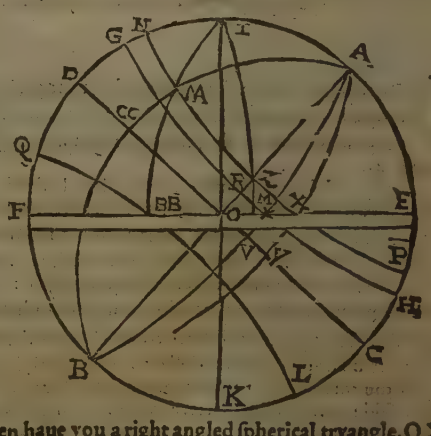
Reckon the including side giuen, videl. A B, being 50. deg on the *Limbe*, from the pole towardes the Equinoctiall, thereto set the rule fixed, then reckon among the parallels from the pole, the quantity of the subtending side giuen, videl. A C, $63\frac{1}{3}$. deg. and where this $63\frac{1}{3}$. parallel doth cutte the rule, there crosseth the $47\frac{2}{3}$. meridian, which cutteth off in the rule 40. degrees, the third side sought for, videl. B C: the same meridian followed to the equinoctiall by the fourth def. sheweth there $47\frac{2}{3}$. degrees, one of the angles sought, videl. the angle A, subtended by B C. And now for the angle C, you neede but shift the sides: that is to saye, reckoning the side subtending it, videlicet A B, 50. degrees on the rule inwardes, and the other including side B C, videl. 40. deg. on the *Limbe* from the pole: the rule thereto applied, you shall see the 62. meridian to cut the said 50. deg. of the rule, which followed to the Equinoctiall by the 4. def. sheweth there 62. degrees the angle sought for.

If the two sides including the right angle, had been giuen vz. 40. and 50. you see by this last woorking for the angle C, that the one reckoned on the *Limbe* from the pole, the other on the rule inwards, and applied together, the third side leaps into them being alwaies a portion of some one of the meridians.

I could yet shew you 2. wayes more to worke with a right angled triangle, but more combersome then commodious, yet in the 24. chap. I shalbe driuen to one of them, & for your farther liking of these past, I wil frame another proposition to apply them to vse as followeth.

Chapter 8.

The quantity of the longest day in any countrey giuen, to know the latitude, and in what climate the same is.



FOr example: heere at Reading our longest day is 16. houres 24. min. whereby the semidiurnall arche must needs be 123. deg. as in my 3. booke 22. chap. is shewed, admit the latitude vnknowne, which semidiurnal arch is in this figure, X N, or rather Y D: whiche if you take out of 180. videl. D Y C, there resteth 57. deg. the arch X P, or rather by the 4. def. Y C. VVherefore you haue here the right angled spherical triangle, A E X, the angle E being a right angle by the 3 def. whose subtending side A X is knowne. If you subduct the declination of the tropicke, vz. Y X, $23\frac{1}{3}$. deg. out of 90. vz. Y A to be $60\frac{1}{2}$. deg. and one of the angles not right: vz. E, A X being 57. deg. as is saide: wherefore by the 9. chap. the side A E shall be found $51\frac{2}{3}$. deg. the latitude sought for: but this proposition serueth hitherto vnto this next chapt. following, being the speedier course in this question, but if you woulde haue done it by the 4. 6. or 7. chapt. which require 2. sides giuen, then should you out of the semidiurnall arch X N or Y D, take 90. vz. D O, there resteth O Y 33. deg. and then haue you a right angled spherical tryangle, O X Y, Y being a right angle by the 3. def. and 3. theoreme, whose two sides including the right angle, videl. Y O, 33. degree, and X Y $23\frac{1}{2}$. deg. are knowne: wherefore, by the first part of the 4. chap. or the last part of the 6. or 7. the side X O is had, which is the Sunnes amplitude in that country, he beyng in ♋, then take X O, now known out of 90. vz. O E, there resteth X E, wherfore now you haue the former triangle A E X of 2. known sides, videl. X E, one of the sides including the right angle E, and the complement of X T vz. X A, subtending E. Therefore by the first part of the 6. or 7, or the last of the 4. you maye easilye knowe the side A E beeyng the eleuation of the pole or latitude sought for, then for the climate you may learne by the thirde booke 22. chap.

I might haue shewed you an easier waye by the tryangle Y O X, and neuer driuen you to seeke further for the angle X O, T beeyng the arche, E C by the fourth def. is the depression of the Equynoctiall vnder the Horizon E F, whose complement E A, is the eleuation sought for, or more easilye the

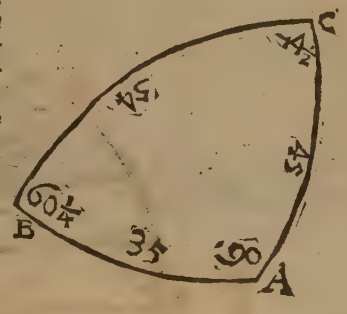
the angle D O F: being equall to the angle X O Y, by the 5. theoreme, is the equinoctials height aboue the horizon his complement being D I, by the 1. Chapt. is the latitude sought for by the first booke 12. Chap. Thus you see how aboundantly the sphericall triangles are like to serue your turne in euerie question.

Ioh. Regimon. lib. 4. Cap. 27. Copernic. 4. triangle spher.

Chapter 9.

If one side of a right angled spherical tryangle, with one of the two angles not right be giuen, how to finde the other two sides and angle.

LEt there be proposed the right angled spherical triangle A B C, whose sides A B and A C doe include the right angle A of which *A B* is knowne to be 35. degrees, and the angle C, subtended by the side *A B*, knowne likewise to be $44\frac{1}{2}$ degrees: the third angle *B* with the sides *A C*, and *C B* knowne.



If you will worke after the 4. Chapter, reckon on the *Limbe* from the equinoctiall vpwards, the angle knowne vz. $44\frac{1}{2}$ deg. thereto fixe the rule, then reckon the subtending side giuen vz. *A B* 35. degrees among the parallels, and you shall finde the 35. parallel to cutte the rule in the $54\frac{1}{2}$ degrees counted from the centre, the same is the quantitie of the side *B C*, subtending the right angle, in which cutting you shal also see the 45. meridian to crosse which followed to the equinoctial, as in the 4. Chap. giueth on the equinoctiall line 45. degrees, for the third side *A C*, thus hauing al three sides, the third angle at *B*, you may easily haue by the 4. 6. or 7. Chapt.

You will say, what if the said angle C vz. $44\frac{1}{2}$ degrees, and the side *A C* 45. degrees, had beene giuen, I will shew you to get the other two sides and angle by the doctrine of the 7. Chapter, because I will vse you to them all. Reckon this side giuen vz. 45. on the *Limbe* from the pole, thereto fixe the rule: then on the equinoctiall from the *Limbe* inwards, reckon the angle giuen vz. $44\frac{1}{2}$ degrees, and follow the meridian there to the rule, and you shal finde on the same $44\frac{1}{2}$ meridian betweene his crosing of the rule, and the pole $54\frac{1}{2}$ deg. for the side *B C*, and the degrees of the rule betweene the same crosing and the *Limbe* 35. deg. the side *A B*.

Yet me thinkes I heare you say what if the subtending side *B C* were knowne $54\frac{1}{4}$ deg. with the angle *B* $60\frac{1}{2}$ degrees, and the rest vnknowne, I will then shew you to performe this by the 6. Chapt. because we wil set them all on worke.

Place the zenith line euen with the equinoctiall line fixed, as there is shewed: and then on the *Finitor* line from the centre vpwards, reckon the angle giuen vz. $60\frac{1}{4}$ degrees, and vpon the $60\frac{1}{4}$ azimuth bounding there, reckon the side *B C* giuen, vz. $54\frac{1}{2}$ from the zenith point, and there shall you see to crosse the 35. meridian counted from the *Limbe*, shewing in the zenith line 35. deg. for the side *A B*, and from that crosing you shall finde on the same 35. meridian downe to the zenith line 45. degrees for the side *A C*, and thus haue I serued euery turne.

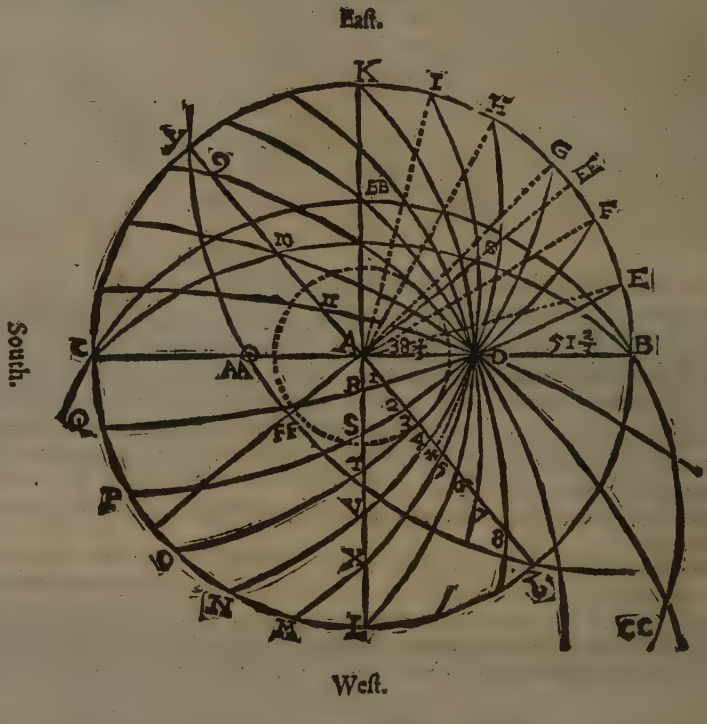
Chapter 10.

If you would make an horizontall or verticall Dyall to any countrie, how by this last Chapt. to finde what number of degrees euery houres space containeth.

YOu must not here be ignorant that those meridians of the sphere which deuide the equinoctiall into 24. equall parts being euerie 15. counted from the meridian of any countrie, are called specially the houre-lines, these cut any oblique horizon into 24. vnequall parts, as in this figure you may see D E D, F D G D H &c. rounde, where the circle B L C K representeth the horizon B C the meridian, and D the North pole eleuated $51\frac{2}{3}$ degrees aboue B. the North point of our horizon heere at Reading: to which intersections B E F G H I &c. if there be streight lines drawne or imagined from the centre of the horizon vz. A, your diall is made, and with a circle concentricke to the horizon, you may cut him off to any quantitie, as here you see the little circle, but hereof I must needs more aboundantly speake in the beginning of my 6. booke, and therefore I referre you thither.

In the meane time to delight you with the singuler profite of these spherical triangles, I will shew you by them to finde the quantitie in degrees of the horizon betweene euery of these intersections, and because euery quarter of an horizon diall hath like spaces, so that by one quarter the whole may be made, I wil for your ease and mine, beginne in one of the north quarters, though we commonly leaue them halfe out: where, for the 1. houre you may see there is the right angled spherical triangle E B D (for that *D B* lighteth perpendiculer on the arch *E B* by the third diff.) whose side *D B* is knowne to be $51\frac{2}{3}$ deg. the poles eleuation, and the angle E D B must needes be 15. degrees by the 4. diff. because 15. degrees of the equinoctiall are taken to one houre, wherefore working by the seconde part of this last Chapter, hauing now one side and one angle giuen, you shall finde the side *E B* $11\frac{1}{2}$ deg. Then for the second houre you haue the right angled triangle F B D, whose

one ſide B D is knowne, & one angle vz. F D B, the quantitie of 2. houres which muſt needs be twiſe 15. that is 30. degrees, theſe had by this laſt Chapter, as before you ſhall finde the ſide B F $24\frac{1}{6}$ degrees, then for the third houre you haue the right angled triangle G B D, whoſe angle G D B is thriſe 15. vz. 45. degrees, by which and the ſide B D, you ſhall get the ſide G B 38. degrees, and ſo for the reſt. Note that B D, vz. $51\frac{2}{3}$ deg. taken out of B A vz. 90. leaueth D A $38\frac{1}{3}$ degrees, the complement of B D, which added to A C vz. 90. alſo maketh $128\frac{1}{3}$ the arch D A G, by helpe whereof I might haue begunne with one of the ſouth quarters, as for the firſt houre you haue the right angled triangle D C Q, whoſe ſide D C is $128\frac{1}{3}$ deg. and his angle C D Q 15. deg. knowne, as in the former way, and therefore by the 9. Chapter you ſhall get the ſide C Q. $11\frac{1}{2}$ deg. euen equall to E B, for as I told you in euerie quarter, the match ſpaces are equall, that is to ſay, if they be of like diſtance from the nooneline, alſo commonly in the ſphere *Oppoſitorum eadem eſt ratio*, and ſo I leaue you for this diall.



Now for the verticall Diall which we commonly call the ſouth wall Diall. The circle L A K, being the verticall circle of the aſt croſsing the meridian B A C, ſquare in the zenith A, is in trueth the horizon of this wall, aboue whoſe flatte ſouthwards the ſouth pole is eleuated with our antipodes, but Northwards, the north pole D is eleuated, and that viſiblie in our countrie according to the quantitie of the arch D A being the complement of B D, as I ſaide, which flat L A K the 24. hourelines doe vnequally deuide in L X V T S &c. but one halfe of the interſections are quite vnder our horizon, and therefore this Dial hath in our countrie viſilbie but 12. houres: but to come to the matter, you haue for the firſt houre of the quarter A L, the right angled ſpheriall triangle D A R, whoſe ſide D A is $38\frac{1}{3}$ degrees, and his angle A D R 15. degrees, wherefore the ſide R A cannot be vnknowne by the ſaid ſecond part of this laſt Chapter, which ſhalbe the quantitie of the firſt houre. Likewiſe for the ſecond houre you haue the triangle D A S, his ſide D A knowne, and the angle A D S, being 30. deg. and ſo forth with all the reſt.

Chapter 11.

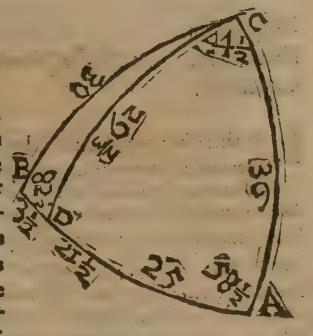
Ioh. Reg. lib. 4. ca. 34. & lib. 5. cap. 3. & 4. Cop. 3. triang.

If the three ſides of any ſpheriall triangle whatſoeuer ſhall be giuen to finde the quantitie of euerie of his three angles.

OF this matter Ioannes Regiomontanus maketh three long diſcourſes In three ſeuerall Chapters, with verie tedious buſineſſe by his Sines, Supplements &c, but my *Iewel* you ſhall ſee will make ſhort worke. For

For if the three sides giuen bee of a right angled triangle, then I perswade my selfe that you are sufficiently instructed by the 4. 6. and 7. Chapt. to finde all the angles, but yet whether the triangle giuen be right angled or not right angled, (for it is hard to know that by the bare sides giuen) you shall and may worke in manner following to come by the three angles.

Let there be proposed the spherical triangle A B C, whose three sides are knowne vz. A B 25. degrees A C 36. and B C 30. but the angles A B and C, all vnknowne, which to know you shall reckon any one side (as for example) the side A B vz. 25. degrees on the *Limbe* from the pole any way, thereto lay the zenith point of the *Reete* fixed, then number one of the two sides remaining as B C vz. 30. among the almicantares, counted from the zenith point of the *Reete*, and the third side A C vz. 36. deg. among the parallels, counted from the pole, now where this 30. almicantare, and 36. parallel do crosse, there shall you find to crosse the $58\frac{1}{2}$ meridian, and the $82\frac{1}{2}$ azimuth both counted from the *Limbe*, whose portions lying betweene the pole and the zenith, if you marke them, doe liuely represent your triangle sought: for the portion of this $58\frac{1}{2}$ meridian betweene this crosing and the pole being as you may there see 36. degrees, numbred by helpe of the parallels, is the side A C: and the portion of the $82\frac{1}{2}$ azimuth lying betweene this selfe same crosing, and the zenith being there 30. degrees, is the side B C, and the portion of the *Limbe*, betweene the zenith and the pole being 25. degrees is the side A B, I say these three arches liuely represent vnto you the forme of the tryangle, whose sides were giuen, and that as expresly as on the Sphere it selfe. VVherefore if you aske counsell of my fourth diff. you will followe this $58\frac{1}{2}$ meridian downe to the Equinoctiall, where it sheweth you $58\frac{1}{2}$ degrees counted from the *Limbe*, the angle subtended by the side B C, vz. the angle A. In like manner the $82\frac{1}{2}$ azimuth followed to the *Finitor*, sheweth $82\frac{1}{2}$ degrees, the angle subtended by A C, vz. the angle B. And yet doe we lacke the angle C, which will be the easier had, now the rest are knowne: wherefore place one of the sides not subtending the vnknowne angle C, videlicet, either the side A C, or B C betweene the zenith and the pole, as before you did the side A B, and heere for example A C: then among the meridians, reckon from the *Limbe* the quantitie of the angle subtended by the second side B C, vz. $58\frac{1}{2}$ degrees vpon this $58\frac{1}{2}$ meridian, reckon from the pole the third side subtending the angle you seeke, vz. A B, 25. degrees, and there shall you finde to cut the $44\frac{1}{2}$ azimuth, which followed to the *Finitor* line sheweth $44\frac{1}{2}$ degrees, the quantitie of the angle C: and heere againe doe the three portions of the *Limbe*, the $58\frac{1}{2}$ meridian, and the $44\frac{1}{2}$ azimuth represent your triangle proposed.

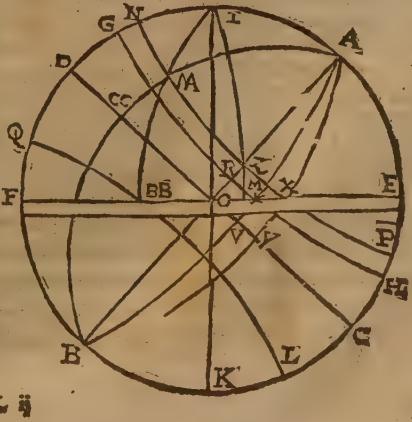


In briefe: Of the three sides giuen, place the one betweene the pole and the zenith: of the other two reckon the one among the parallels counted from the pole, the other among the almicantares counted from the zenith: where these two crosse, there shall meete an azimuth and meridian, whose portions from their meeting to the pole & the zenith, with the portion of the *Limbe* lying betweene the pose and the zenith, shall represent your triangle, and the two distances betweene the *Limbe*, and the saide azimuth and meridian are two of the angles. For the third angle you are to shift the sides, that is to say, to place one of the other sides betweene the pole and the zenith, and then worke as before.

Chapter 12

The declination of the sunne giuen at any time togither with her altitude aboue the horizon, how by meane of the 11. *Chapt. to get what houre and minute it is, and in what azimuth the sunne then is.*

FOr example admit that the 12. day of Iune when as the sunne is in or verie neare the tropicke of Cancer being in this figure P N, and therefore his declination $23\frac{1}{2}$ deg. vz. N D, I had then taken his altitude $53\frac{1}{2}$ deg. take the complement of his declination, which is $66\frac{1}{2}$ and also of his altitude which is $36\frac{1}{2}$ degrees: the first is the distance of the sunne from the pole, the seconde from the zenith at the time of the altitude taken videlicet A AA, and I AA, which with the arch A I, maketh vp the triangle A I, AA of the three knowne sides vz. A AA, $66\frac{1}{2}$ I AA, $36\frac{1}{2}$ and A I $38\frac{1}{3}$, being the complement of the latitude, wherefore by the eleuenth Chapter the angles shall be all knowne, of which the angle A I, AA is the distance of the sunne from the south so founde 30. degrees, that is two houres: wherefore if it were morning, then was it tenne



of the clocke, if afternoone, two of the clocke. Alſo A I, A A, muſt needes bee the diſtance of the azimuth wherein the ſunne then was from the North, found by the 11. 130. deg. if out of that you take 90. there reſteth 40. deg. vz. O. B B, the diſtance of the ſame azimuth, from the Eaſt or weſt, and that towards the ſouth. I am the briefer becauſe I meane onely to giue you a taſt of the vſe of theſe triangles, knowing this alſo to be verie eaſie to conceiue, to them that vnderſtand the 4. bookes paſt euen by the bare inſpection of this figure.

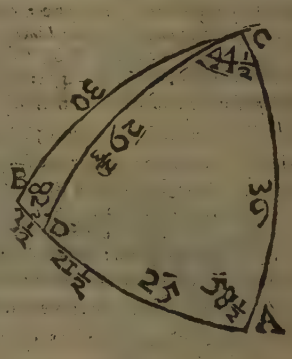
Ioh. Regiom. lib. 4. cap. 28. Copern. 11.

Chapter 13.

If of a ſpherical triangle two ſides containing any one knowne angle ſhalbe giuen, how to finde the other ſide and angles.

LEt there be propoſed the ſpherical triangle A B C, whoſe angle A, let it be knowne 58½ degrees togither with the two ſides, containing it vz. A C 36. degrees, and A B 25.

Reckon the quantitie of the one ſide giuen, as of A B, 25. deg. on the *Limbe* of your *Iewel*, thereto lay the *Reetes* Zenith fixed: then on the meridian diſtant from the *Limbe*, as much as the angle A propoſed commeth to videl. on the 58½ meridian, reckon from the pole the quantitie of the other ſide propoſed, videl. of A C 36. degrees, and looke what azimuth croſſeth the ſame 58½ meridian in the ſaide 36. deg. the ſame followed to the *Finiter*, ſheweth the degrees of one of the angles ſought for, videlicet of the angle B ſubtended by the ſide 36. which you ſhall finde 82½ degrees counted from the *Limbe*: then are the degrees of the ſame 82½ azimuth betweene the ſaide croſsing and the zenith the quantitie of the third ſide ſought for, which you ſhall finde to be 30. deg. Thus doe you ſee according to your accuſtomed manner your whole triangle in his forme, his three ſides, & two angles knowne, wherefore by the 11. Chapter the third angle is eaſily had in the laſt part of which Chapter, this Chapter was performed ere I was ware, ſuch is the dexteritie of my *Iewel*, neither woulde I haue repeted it here againe, had it not beene to imitate the courſe of Regiomontanus and Copernicus.

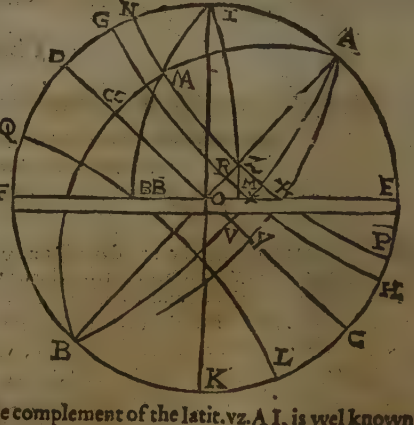


In briefe, lay the one ſide giuen betweene the pole and the zenith, the other reckon on the meridian as much diſtant from the *Limb*, as the angle giuen commeth to, there ſhal meete you the azimuth making vp your triangle.

Chapter 14.

How by helpe of the 13. Chapt. to know the height of the ſunne at any houre, and minute propoſed in the whole yeare, and alſo in what azimuth he is.

IN my thirde booke 31. Chapter is ſhewed the ſame by ordinary vſe of the *Iewel*, and that moſt exact and redily without any trouble, yet ſhall it not be amiſſe to know to do the ſame by the Art of ſpherical triangles, which performeth it as reddily as Gem. Friſius did on his Catholicon, though nothing ſo eaſie as my *Iewel* doth it in the ſame 31. Chapt.



For example the 12. of Iune, the ſun then being in the 1. degree of ♋ his declination there 23½ deg. I woulde know of what height, and in what azimuth the ſun ſhall then be. The angle made betweene the 10. of the clocke houreline, and the meridian being in this figure, the angle AA, A I, muſt needs be 30. deg. for that euery houre is 15. degrees, then taking the ſunnes declination for that day vz. D N, or rather CC AA 23½ deg. out of 90. deg. videl. C C A, there reſteth the arch of the 10. of clocke houreline betweene the tropicke or ſunnes declination, and the pole vz. AA, A being 66½ degr. Then the portion of the meridian betweene the pole and the zenith, being alwayes the complement of the latit. vz. A I, is wel knowne 38½ deg. Here then haue you a ſpherical triangle AA, A I, whoſe two ſides A I, and AA A, are knowne, including the knowne angle AA, A I vz. 30. deg. wherefore by the 13. Chapt. the 3. ſide I A A ſhalbe knowne 36½ deg. and the angles A I, AA & AA, A I, ſhal alſo be knowne: Now then ſubduct the ſaid third ſide I AA vz. 36½ deg. being then the diſtance of the ſunne from the zenith out of I BB vz. 90. deg. ſo reſteth the arch AA, BB 53½ deg. the altitude of the ſunne ſought for, and the angle A I, AA, ſheweth the azimuth of the ſun in the very ſame manner, as in the 12. Chapt. hath beene ſaid.

Chapter

Chapter 15.

Ioannes Regiomontanus, Lib. 1. Cap. 51. and lib. 4. cap. 29. *proposeth and sayth that the knowing of two sides of a triangle not right angled, with one angle subtended by one of those sides, cannot serue to get the other side and angles.*

HEere is a wonderfull case, that by their whole art of spearicall triangles, with their signes, coardes, arches complements, proportions, calculations, tables, and such like, they cannot doe that which my poore *Iewel* will doe immediatly without any difficultie. Nay all the sporte is, Regiomontanus spendeth muche speache in the saide 51. and 29. chapter, to proone that it is vnpossible to bee done, without letting downe a perpendiculer, respecting or subtending the angle proposed, which in the thirtieth chapter following, hee teacheth to doe. But we will doe it, add that without any perpendiculers, a little readier then he doth it.

The figure of the 11. Chap. serueth for this place.

Admit that of the triangle A B C, proposed in the thirteenth chapter, the two sides A B, and A C, wer knowen as there they were, together with one of the angles B or C, subtended by one of the sides giuen: for example, the angle B $82\frac{1}{2}$. degrees, subtended by A C, & that the angles A and C were vnknowen, with the side B C: Is it not possible thinke you by these three giuen, to reache to rest, I hope it be, els I loose my labour.

Reck õ on the *limbe* of the *Iewell* frõ the pole þ̃ side giuen, not subtendyng the angle giuen, vz. þ̃ side $\mathcal{A}B$, being 25. degrees, thereto lay the zeneth point of the *reete* fixed, reckon also on the *Finitor* from the *Limbe* inwards, the angle *B* giuẽ, vz. $82\frac{1}{2}$. de. there haue you the $82\frac{1}{2}$. azimuth, then reckon the other side giuen, vz. A C. 36. degrees among the parallels, counting from the pole, mark where this 36. parallel, and the said $82\frac{1}{2}$. azimuth doe crosse. For the portion of the meridian cutting there, counted too the pole, is the thirde side, which you shall finde 30. degrees, of the $58\frac{1}{2}$. meridian counted from the *limbe*. The same $58\frac{1}{2}$. meridian followed also to the equinoct. sheweth $58\frac{1}{2}$. deg. one of the angles sought for, vz. A. The third angle C cannot be vnknowen by the 11. or 13. Cha. Thus you see this vnpossble matter now possible, then iudge whether my *Iewel* bee a *Iewell* or no.

Yet thus much will I foretell you, least happily you shoulde be amazed at any time. In some triangles you shall finde that the azimuth representing the angle giuen, will crosse the parallel that worketh this feate in two places, and then shall you not tell which place of crosing to take, yet commonly the crosing farthest within the *Limbe* is hit: in all the triangles that I haue had experience of, but you may trie by shifting of the sides, as you are wont to doe in finding the thirde angle which is it.

Chapter. 16.

The azimuth of the Sunne giuen or taken at any time by Instrument, with his declination, how by helpe of the fifteenth Chapter, to knowe what height the Sunne is of, and what it is a clocke.

IT is taught in the 12. chapter, spherically to get the houre & azimuth of the Sunne by his altitude, contrariwise, heere by the azimuth shall bee hadde the houre and the altitude.

The figure of the 5. chap. serueth for this place.

For example, the 12. of Iune, admit that before noone I had takẽ by some Topographicall Instrumẽt, or otherwise the azimuth or horrizontall distance of the Sunne 40. degrees from the East towardes the South, which in this figure is O B B, thereto I adde 90. degrees, videlicet, E O: so haue I the arche *EBB* 130. deg. the declination of the Sunne then is $23\frac{1}{2}$. degrees, by the 3. booke and 4. chapter. Nowe it is most manifest, and apparantly to bee seene on the *Iewel*, that any parallell of the spheare doth cut off the meridians, or houre lines, all of like equall distance from the pole, as heere you shall see the arches of the houre lines A X. A Z. A AA, A N, are all complements of the Sunnes declination: each of them, and namely A AA, $66\frac{1}{2}$. beeing $66\frac{1}{2}$. degrees, the arche betweene the pole and the Zenith, vz. A I, is certaine $38\frac{1}{2}$. degrees. Here haue you nowe a spherical triangle A I, AA, whose two sides A I, and A AA, are knowen with the angle A I, A A, which angle is subtended by A, AA, one of the knowen sides, euen the like too that whiche the fifteene chapter proposeth. The third I, AA, and the angles AA, A I, and A, AA I, are vnknowen. VVherfore if the worlde were so harde, and the matter so vnpossible, as Regiomentanus proposeth it, we shoulde bee neuer the neere of our purpose: but working by the 15. chapter, notwithstanding his proofes too the contrary, you shall finde the angle $I\mathcal{A},\mathcal{A}\mathcal{A}$, 39. degrees, the Sunnes houre distaunce from the South, which must needes be two houres euen ten of the clocke: also you shall finde the thirde side, $I,\mathcal{A}\mathcal{A}$. $36\frac{1}{2}$, degrees, whiche taken out of 90. vz. I,BB, leaueth the arch $\mathcal{A}\mathcal{A}$ BB, $53\frac{1}{2}$. degrees, the height of the Sun at that instant. As for the thirde angle, you shall finde him 32. degrees, but wee haue no vse of him here.

Ioh. Regio. lib. 4. cap. 31. & 32. Copern. 12.

Chapter 17.

If of any ſphearical triangle, not right angled, two angles ſhalbe giuen with the ſide lying betweene thoſe angles or els the ſide ſubtending one of them, how to get the other two ſides and thirde angle.

IF the ſide lying betweene thoſe angles ſhall bee giuen, it is moſt eaſie, for placing that ſide on the *limbe* betweene the pole and the Zenith as you are wont, & reckoning the one angle giuen among the azimuthes, the other among the meridians, where theſe croſſe, ther is your triangle made vp, in your wonted maner. For example, admit that of the triãgle A B C, the two angles A, 58½. deg. & B 82½. degrees were giuẽ with the ſide AB, 25. deg. lying betweene them: reckon AB, vz. 25. deg. on the *Limbe* from the pole, thereto lay the Zenith of the *Reete* fixed: that done, reckon the one angle, vz. A 58½. deg. amongſt the meridianes, the other angle vz. B 44½. deg. amongſt the Azimuthes both from the *Limbe*, and where this 58½. meridian, and 44½. azimuth, do croſſe, there ſhall you finde your triangle made vp after your accuſtomed maner, for on the 58½. meridian between the croſsing, and the pole, you ſhal find 25. deg. for the ſide A B, & on the 44½. azimuth to the Zenith 30. deg. for the ſide B C, theſe had, the third angle is to be had by the 11. or 13.

The figure of the 11. Chap. ſerueth for this place.

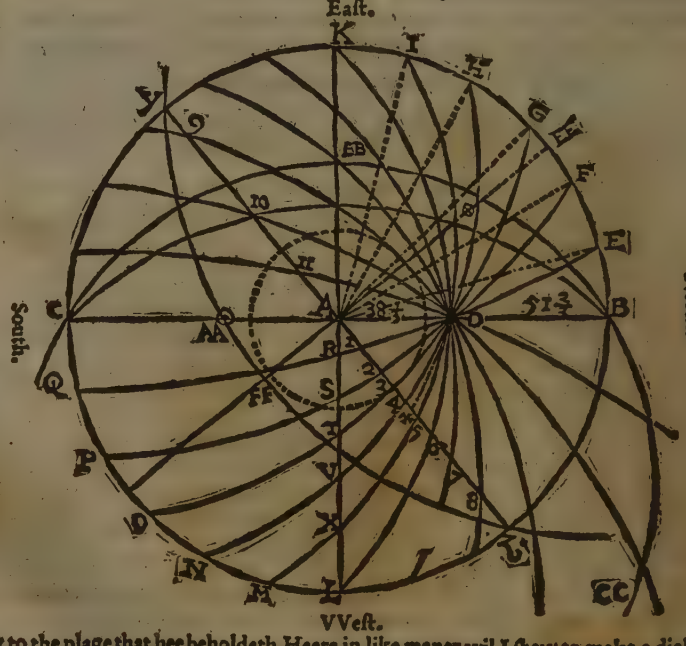
But admit, that one of the ſides A B, or B C, ſubtending one of the angles A or C, had beene giuen with the ſaide angles A and C: as for example, the ſide B C, ſubtending the angle A. Heere reckon the one angle giuen, vz. 58½. de. ſubtended by the ſide giuẽ as before among the meridians, the other, vz. 44½. deg. among the azimuthes, that done, number on the ſaid 44½. azimuth counting from the Zenith, the ſide B C, giuen, vid. 30. deg. and turne the *reet* til the ſame 30. deg. of the ſaid 44¾. azimuth do cut the ſaid 58½ meridiane, and there is your triangle made vp as before for you ſhall finde the Zenith too cut in the *limbe* 36. deg. from the pole, as before he did, and the very ſame croſsing as before.

Chapter 18.

Howe by the helpe of the 17. chap. to make any declining diall, that is to ſay, a dial to any wall ſhouldring or bending from the full beholding of the South.

ALl walles are commonly made perpendiculer to the horrizon wheron they ſtand, and point directly to the Zenith. VVherefore of neceſſitie they muſt lie euen in the flat of ſome one of the azimuthes, and therefore euery one, ſome one horrizon in the worlde by the preambles to my 6. booke, where this matter is handled more at large.

But now to the concluſion of this chapter, where as I taught you in the 10. chap. ſphearically too make a diall to the North flat of the wall, lying directlie East and VVeſt, which wee call a North or South wall, vz.



K L, according to the plage that hee beholdeth. Heere in like maner wil I ſhew to make a diall to the North flat of a wall, declining from the former Eaſtwards, howe much ſoeuer, and for example, 40. degrees repreſented in this figure by the azimuth Y Z, where by the angle K A Y, ſhalbe 40. degrees, and as much is the angle

angle Z A L, by the 5. Theoreme, further the angle K A Y, vz. 40. taken out of K A C, videlicet, 90. leaueth his complement the angle Y A C, 50. degrees, to the which the angle B A Z, muſt needes bee equall by the ſaid 5. Theoreme. This circle Z A Y, ſince it repreſenteth here an oblique horrizon, therfore the 24. meridians, or rather houre lines iſſuing from the pole D, ſhall cut the ſame, Z A Y, into 24. vnequall partes, where you ſee 1. 2. 3. 4. &c ſeruing for the houres euen in the very like maner, as to the horrizon K A L, they did in the tenth chapter, and how much euery of theſe houre ſpaces containeth: I will nowe alſo teache to finde by helpe of the 17. chap. The firſt houre line from our meridian VVeſtwardes towardes L, videlicet, D Q, doth cut this horrizon: Z A Y, in the point I. VVherefore the quantitie of the arche, I A, ſhalbe the degrees of the firſt houre from our meridians VVeſtwardes, which in this diall is 11. of clock, as by the 6. booke will more at large appeare. Heere haue you nowe a ſphearicall triangle D A I, whoſe ſide D A, is knowen, as hath often been ſaide to bee $38\frac{1}{3}$. degrees. The angle A D I, beeing the quantitie of one houres ſpace, muſt needes bee 15. deg. the angle D A I, is as before is ſaide, knowen 50. deg. theſe had, videlicet, the angles A, D I and D, A I, with the ſide A D, lying betweene them: you ſhall moſt eaſily by the firſt part of the 17. chapter finde the ſide I A, to bee $12\frac{1}{2}$. degrees, ſo much is the ſpace of the firſt houre VVeſtwardes of the plum line in this diall, then the ſecond houre line, vz. D P, hee cutteth the horrizon Z A Y, at the note 2, there haue you another triangle D A, 2. whoſe angle A D, 2. is knowen to be 30. becauſe it is 2. houres ſpace, & the angle D A, 2. 50. as before with the ſide D A, lying betweene them, vz. $37\frac{1}{3}$. VVherefore by the 17. you eaſilye obtaine the arche D, 2. being the diſtance of the ſeconde houre line of your diall, weſtwards of the plumme line. For the third houre you haue the triangle D A, 3. and ſo cõſequently for all the reſt on that ſide of the meridian B C, where ſtill the ſide A D, and the angle D A Z, are common too them all. But nowe for the houres, one the Eaſt ſide betweene A and Y, the angle B A Y, muſt bee the common angle, whiche is eaſily had by adding the angle K A Y, videlicet, 40. to bee A K, vz. 90. thereof commeth the angle D A Y. 130. deg. ſo that for the firſt houre on the Eaſt ſide you haue the triangle D A 11. whoſe ſide D A, & the angles D A, 11. and A D, 11. are knowen: thereby get the quantitie of the ſide A, 11. for your firſt houres ſpace, & ſo for the reſt.

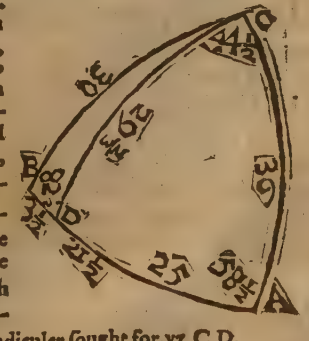
Heere note that as this figure ſheweth the maner of the cutting of the houre circles, to the North ſide or flat of this wall Z A Y, iſſuing from the North pole D. ſo if you would haue made the diall to the South flat of Z A Y, you muſt haue placed the South pole in your figure $38\frac{1}{3}$. deg. Southwardes in the line A C, vid. in A, from whence the houre lines iſſuyng will cut the South flat of Z A Y, in his right forme: but truly into the very ſelfe ſame diuiſions as before: yet in contrary quarters, for then the diuiſions, which are now in the quarter A Z, will be there in the quarter A Y, *& è conuerſo*: then alſo is the point A, no more the zenith but his Nadir. and A A A, the arch between the Nadir, and the South pole. But what needs all this, when as one mould turned vpſide down, or in & out, will ſerue to diall both the flats, and two more of their couſins as in my 6. booke and 20. chap. is ſhewed, in which booke very many more things neceſſary to dials are ſhewed which to bring in here, wold bring me out of my ſpherical triangles, & that muſt not be. But thus much aſſure your ſelf, you hauing read & well vnderſtood my 6. booke of diallyng, you ſhall euer after by the precepts of this, the 10. & 22. chap. make dials to any wall or flat whatſoeuer, for thoſe three include the whole art. Much more, and many wayes I could write, but for breuities ſake, which I wholy intende, theſe ſhal ſuffice.

Chapter 19.

Ioh. Regio. Lib. 4. Cap. 8. & 30.

How to let downe a perpendiculer arche from any angle of a knowen ſphearicall triangle vnto his baſe or ſubtending ſide, and to know the quantitie of the ſame perpendiculer, and of the parts whereinto hee deuideth the baſe.

LET there be propoſed the triangle A B C, of the 17. chapter, of knowen ſides and angles, from whoſe angle C, I woulde let fall a perpendiculer arch to his baſe, or ſubtending ſide A B. Firſt you know that euery perpendiculer arche muſt haue his originall from on of the poles of the ſide or circle, whereon it muſt light by the 3. diff. wherefore you ſhal alwayes place that ſide. vz. A B. 25. degrees on the *Limbe*, betweene the pole and the zenith as you are wont, then is the center of your *Iewell* the pole or poles of the circle, wherein the ſame ſide A B, conſiſteth by the 2. diff. Therefore make vp the other two ſides of your triangle as you are accuſtomed, either as in the eleuenth chapter, by the croſsing of the almicantare and parallel, equall to the other two ſides, or els of the meridian and azimuth, equall too the other two angles, as in the 17. at whiche croſsing, the angle C, muſt needs be included. VVell, then vpon the croſsing of the $82\frac{1}{2}$. azimuth, and the $58\frac{1}{2}$. meridian (if you worke by the 17.) of the ſaide almicantare and parallel: if by the 11. laie the fiduciall or center line of the *labell*, which ſhall there deuide the 25. lying on the *limbe* between the pole & ϕ zenith into $3\frac{1}{2}$. degrees, vid. the arche B D, and $21\frac{1}{2}$. degrees, the arch D A, the partes of the baſe ſought for. And the degrees of the *labell* betweene this croſsing, and the *Limbe* ſhall bee $29\frac{2}{3}$. degrees, the perpendiculer ſought for, vz. C D.



Chapter

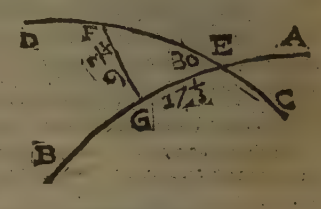
Chapter 20.

To doe the same after another manner of working, yea though one of the other two angles, and one of the other two sides, of the triangle were vnknowen.

ADmit, that frō the angle C, of the triangle A B C of this last chapter, I woulde know the perpendiculer, and the partes he diuideth the base into, by another maner of working: to doe this, you shall reckon one of the other two angles B or A. For example A. 58½. deg. on the *limbe* from the Equinoctiall vpwardes, thereto lay the rule fixed, whereon you shall from the center reckon the side, which with the base includeth this angle A, vz. A C, 36. deg. & there shall crosse you the 21½. meridian counted from the axtree, shewing on the Equinoctiall line 21½. degrees, the portion of the base cut of the next angle, A, videlicet. A D: and the portion of the same 21½. meridian betweene the crosing of the rule and the Equinoctial, you shall finde, 29⅔. deg. being the perpendiculer C D. The other portion of the base, is had by subducting this 21½. out of the whole base giuen, videlicet, A B, 25. deg. and all this is done without knowing the angle B, or the side B C. This working differeth nothing from the 9 chapter, if you mark it: but only it bringeth you acquainted with perpendiculers: you might also haue done it in this maner by the 19. chapter, or partly by the 7. the skill is not great, so you vnderstand well where about you goe.

Chapter 21.

If two great circles of the sphearе crosse one another, making a knowen angle howe to get the perpendiculer arche, falling from any poynt assigned of the one circle vnto the circumference of the other, together with the arche of the same circle, betweene the perpendiculer, and the crosing.



LET there bee proposed the two great circles A B, and C D, crosing one another at E, making the knowen angle, D E B, 30. deg. Admit that from the point F, of the circle C D, beeing 20. deg. distaunt from the crosing E, I woulde learne the perpendiculer arche falling on A B, videlicet, F G, together with the space E G. This matter differeth nothing from the 20. cha. For if on the rule layed at the *Limbe*, to 30. deg. being the angle at the crosing E, you count the distance E F. vid. 20. deg. frō the center, ther shal meet you the 17⅓. meridian whose portion frō the rule to the Equinoct. you shall finde 9¼. deg. your perpendiculer F G, and the saide 17⅓. is the arche E G. Or thus after the 19. chap. if on the 20. deg. of the 30. meridian counted from the pole, you lay the rule, his part there cut of next the *limb*, you shall finde 9¾. and on the *limbe* betweene the rule and the 17⅓. as before.

Chapter 22.

How by helpe of the 21. chapter to knowe both the height of the cocke, to any declining dial, and how much he must be placed byas from the perpendiculer which I call his deflection.

THese rules are general in all vpright walles, the plum line is our meridian, the line where the cock standeth, is the meridian line of the horrison represented by that wall. The meridian circle of euery horrison, standeth perpendiculer thereon, by the 1. booke, & 4. chap. Lastly the eleuation of the pole aboue any horriz on, which is alwayes the height of the cocke, is the arche of the meridian, betweene the pole and the same horrizon, which arch must needes be perpendiculer to the horrizon, aswell as the whole meridian is. Then to conclude in the figure of the 18. chap. you haue the two great circles B A C, and Z A Y, crosing at A, making the knowen angle B A Z. 50. deg. then if from the point or pole D. of the circle B A C. being as in the 18. chap. is shewed 38⅓. deg. from the crosing at A, you can deuise to know the perpendiculer arch falling to the horriz on Z A Y, vz. D, +, which by ♑ 21 you shall find 28. de. the same is ♑ height of the cocke to that diall, and the space + a, is the quantitie of the angle of deflection, vz. 27. by the 21. chap. It were great folly for me to stand longer of this matter, since the selfe same is done in the 6. booke, 16. 17. & 18. chapters, meaning here but a little to touch the vse of the sphearicall triangles for the encouragement of the young Reader.

Chapter 23.

In a right angled sphearicall triangle where one of the angles shal chaunce too bee but certaine minutes as it often hapneth, how to get the side subtending that angle presisely notwithstāding.

FOr example, admit that of the right angled triangle A B C, the angle A, were but one deg. 10. minutes, & the side A B, subtending the right angle C were knowen to be 15. degrees, you might now by the 9. chap.

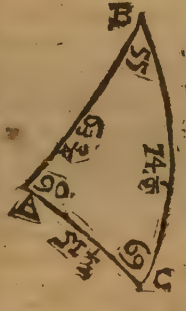
chapter, get the side B C, yet without any exact certaintie, because the angle A is so little, and that the side B C, wyll fall out to bee but certaine minutes, whiche except your *Iewell* be monstrous cannot be discerned any thing neere. To helpe this you shall instead of one degree tenne minutes, whiche are 70. minutes in the whole, reckon on the *Limbe* of your *Iewel* from the Equinoctiall vpwardes 7. degrees, and thereto lay the rule as in the nienth chapter, for so doth euery degree of the *limb* represent 10. minutes. In this case then, as in the 9. reckon on the rule from the center, the side A B, vz. 15. degrees, and there shall you finde the $14\frac{6}{7}$. meridian to cut, whose degrees betweene the crosing of the rule, and the Equinoctiall are $2\frac{1}{7}$. degrees, the side B E, after the 9. chapter. But here you must allowe each degree, but 10. minutes, as you did at the *limbe*, so that this $2\frac{1}{7}$. deg. represent but 22. minutes, so much is the side B C. And in this working you must in no wise exceede 10 or 15. deg. in the *Limbe* at the most, yea and that where the angle proposed exceedeth not two degrees, for in these small or minute angles, as I may terme them, there is kept a Geometricall proportion betwene the parts of the triangle, whiche in greater, the nature of the spheare alloweth not: neither yet in these, but that the error is vnsensible, this helpe did Gemma Frisius inuent, as in my 3. booke 56. chapter appeareth, from whom I woulde be loth to derogate; but in my next edition I will supply it farre better, & more exact, by another deuise euen vnto 30. degrees, which heere you can scant extend to three degrees.

Ioh. Regio. lib. 4. ca. 26. Copern. 5. triang. sphe.

Chapter 24.

If the three angles of a right angled sphearicall triangle shall bee giuen, howe to get the quantitie of the three sides vnknowen.

THis proposition had I once half giuē ouer as vnpossible on my *Iewell*, which made me greatly to mislike him: but in respect hee made mee amendes in perfourming another that Regiomont. left imposible, as by the fifteen chapter appeareth, I thought it a lesse fault, yet still whereseoeuer I went or sate alone, I coulde not choose but be deuising vppon it: and at last while I was abroad, in my eueninges walke, whiche I commonly vsed, it came into my head on the sodaine, but then was it no neede too bidde me trudge a pace home to my *Iewel* to see it in experience. All the skill thereof is too make the right angle too lye among the crosinges of the meridianes and azimuthes within the *limbe* in maner as the one angle of all triangles, not right angled doth, so that when the constitution of the triangle is founde on the *Iewell* his side, which lyeth on the *Limbe* betweene the Zenith, and the pole may be the side subtending the right angle giuen: which you shall thus do. Let there be proposed the right angled sphearicall triangle A B C, whose three angles are giuen vz. C. 69. degrees, B 55. and A 90. I reckon one of the angles not right, vz. 69. among the azimuthes of my *Iewell*, and the other vz. 55. among the meridianes alwayes counted from the *limbe*: this done, all the misterie of this matter is, how in turning about the *Reete* to know when this 69. azimuth, and 55. meridian doe crosse another square, which can neuer be by the 30. def & 3. theoreme except they cut one anothers poles, which poles I may easily know where to finde by the 12. theoreme. By which I say that the poles of euerie meridian of my *Iewell* are to be found in the Equinoctiall line, and not els where. For as it is apparaunt by the third def. and the third theoreme, that the pole or poles of the vttermost meridian, beeing the innermost circle of the *limbe*, lyeth in the Equinoctiall line, in the center of the *Iewel*: So looke how muche euery other meridian lyeth within the *limbe* on the one hand, euen as much doth one of his poles lye distaunte from the center on the other hande. As for example, the pole of the fifth meridian, next the *limbe* on the South part, is the 5. degree of the Equinoctial line from the center towardes the North parte, and so of all the rest, as in my fourth book and fourth chapter doth also appeare, yet thus much more plainely chose out any meridian whose pole you require, then reckon from him on the Equinoctiall line towardes the center, and beyonde till you come to 90. degrees, and there shall bee his pole: as for example, if from the fift meridian on the South part next the *Limbe*, you count on the Equinoctiall Northwardes 90. degrees, the same shal end at 5. de. beyond ỳ center, this matter now I hope is plain enough for you to gather that in the very like maner the poles of all the azimuthes are to bee founde in the *Finitor*, and not els where, wherefore to goe forwards with our triangle you shall by the rules heere last mentioned, reckon on the *Finitor* from the 69. Azimuth, whiche as before was appointed too containe the angle C, tyl you come too 90. degrees, and there shall bee his pole: wherfore if you turn about the *reete* tyll the same 90. degree of the *Finitor* doe touche the 55. meridian appointed before to contain the angle B, then whereseoeuer you shall finde the same 69. azimuth, and 55. meridian to crosse, there must needes be foure right angles by the thirde theoreme, and therefore no



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no doubt but at the same crossing is made vp your triangle desired in his right constitution after the wonted maner, as in very deede it is: for from this crossing to the Zenith point of the *Reete*, you shall find on the 69. azimuth $51\frac{1}{3}$. deg. for the side A C, and thence to the pole on the 55. meridian $63\frac{3}{4}$. deg. the side A B, & on the *limb* between the pole and the Zenith $74\frac{1}{2}$. degrees, the side B C, subtending the right angle A. And now that you haue all, doe, if you list to followe the 69. azimuth vnto the Equinoctiall line, hee will there cutte the 55. deg counted from the center being in truth the pole of the saide 55. meridian by the forsaid computation, which is a great confirmation of this matter, els coulde not there haue been a right angle at the said crossing by the third theoreme, if each did not cut others poles. Thus haue you a most pleasaunt and profitable handling of the chapter, yeelding great light to many questions about the same sphear, which I thought good, the better to manifest by this figure.

B C H, the *limbe* of your *Iewell*, K the center.
B, the North pole of the *Iewel*: N O, the Equinoctiall line.
C, the Zenith of the *reete* placed, M L, the *Finitor*.
C D, the 69. azimuth.
E, the pole of the 69. azimuth, K E, being 69. degrees, or D E, 90.
B F, the 55. meridian, G, his pole, G K, beeing 55. degrees equall to F O, or F G, being 90.
P, the point of the 55. meridian, where E, the pole of the 69. azimuth doth touch in turning the *reete*.
A, the point of their crossing making vp the triangle A B C. desired.

In briefe, of the two angles not right, reckon the one amongest the azimuthes, the other among the meridianes both counted from the *Limbe*, then turne about the *reete* vntyll the 90. degree of the *Finitor* counted towardes the center, and beyonde from the same azimuth doe touch the same meridian, and then whersoeuer you finde that azimuth and meridian, to crosse, there is your triangle made vp in the wonted maner.

Chapter 25.

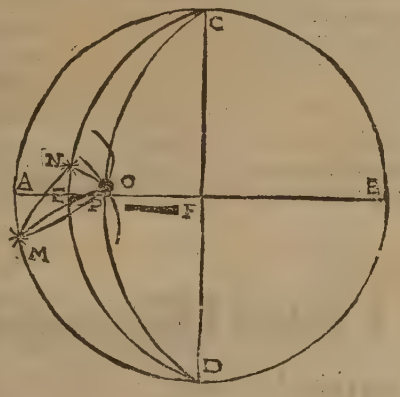
If by the crosse staffe or other Instrument, you shall take the true distance of any planet, comet, or starre vnknowen from two knowen starres, how by helpe of this my woorke of spherical triangles, to get the longitude and latitude in the zodiacke of the same planet, comet, or starre, and also his declination and right ascension: and what you had need to do in al spheарical questions.

I Haue hytherto for the pleasure & delight of the learner, set downe diuers Astronomicall questions, and conclusions to be resolued by these triangles in sundrie chapters before: least otherwise, if I should haue giuen the bare preceptes, as Regiomontanus and others haue done, this work beyng of all the rest most profitble might happily haue been neglected, & thought on the first blush of small account: knowing that nothing draweth on mens minds more to any studie thē that they may at the first entrance perceiue their rules to serue to good purpose. And as I haue hitherto touched a fewe sleight questions: so might I haue witten a number, and therewith filled great volumes, the matter beeing in manner endles, were it not that I both hast the end of my trauaile too too long alreadie looked for of diuers of my familiars, and presume that by those, any man may performe all other that be of no greater waight. But now there are in like maner an infinite number of intricate questions more harder far then any yet propounded, which by Regiomont. Copernicus, and others doctrine, grow to great toile with their Synes, calculations, & proportions, wherin first they hunt about for one Syne, which they call *inuentum primum*, then for another, which they call *inuentum secundum*, & cōmonly *inuentum tertium*, & perhaps *quartum*, & so foorth. After all these are found, then they multiplie & deuide them, & compare their proportions: & when al is done, that they haue founde the Syne sought for: they yet are faine to goe to their tables for the arch correspondent. Those *inuenta* are not ouer easilye done by my *Iewel*: but yet an hundred fold easier then as they performe them: notwithstanding you muste haue all your wits about you, & after a sort seek a *primum, secundum, & tertium inuentum*, as they do, though with no trouble at all: when you haue once the conceite of it in your head. For in all these questions, it is more hard to conceiue how they should be resolued then to resolue them. VVherefore the best way is for any man that hath not well setled the circumstance of the sphеare in his head: first by the helpe of his rule & compasse, or els grosly by ame to drawe an Idea, or shape of such circles as hee shall haue to deale withall in his purpose, as also before in my other slight questions I haue done: which done, hee shal by inspection therof very readily spie out which angles or sides be knowen, & thereby get ♄ rest, or els see how to adde, inuent, or cast out other circles, arches, & triangles, which may help him to his intention, euen as the lande meater doth commonly resolue a cragged deformed ground into sundry squares & triangles, too compasse the contentes thereof, which to do, I hope by this one example following you will be sufficiently instructed for all.

The 14. day of October 1582. about 6. a clock in the morning, & 30. min. past, seeing the morning cleer & ♂, ♁, & the Moone all 3, aboue our horrizon, according to my accustomed maner, I could not choose but haue a cast at them for my recreation, wherefore with a large crosse staffe that I had made after my fashion, as in my next edition I will shew, I tooke the distance between Mars & the great Star in the right shoulder of Orion, & found it 31. deg. $37\frac{1}{2}$. min. Likewise the same instant I took the distance between ♂, & ♄ Northermost of the 2. stars of ♊, called Apollo, & foūd that 10, de. 25. mi. ♂ being orient. of thē both. Hereof I thē made a note in my book where at this time I mean it shal serue for an exāple to this chap. and by this distance of ♂, taken from those two knowen starres, I will shewe you by spheariall triangles to get in what longitude, latitude, declination, and right ascēs. hee then was, by a knowen starre, I meane a star whose longitude and latitude is knowen eyther by tables or your Astrolabe. But now the better to conceaue howe to

bring

bring this matter to passe, my best way is first to make a slight pattern of the thing I pretende in this maner: I make a circle at aduenture, vz. A B, C D, whose diametre A B, shall represent the Ecliptike, the point C, beeing his North pole, and D the South: this done, I goe to Stadius Tables, and there I finde the longitude of the said star of Orion, 23. deg. 0. min. in ♊, his latitude, 17. deg. 0. min. South of the Ecliptick, and the longitude of Apollo 14. deg. 20. min. in ♋, his latitude 9. degrees 40. min. Northwards: this knowen, I appoint the arche C A D, to bee the circle of Orions longitude: that is to say, the great circle of the spheare, cutting the 23 0. of ♊ issuing from the Ecliptickes poles, then taking 23. 0 of ♊ out of 14. 20. in ♋. there resteth 21. deg. 20. min. for whiche I ame out a portion of the Eclipticke A B, containing by estimation $21\frac{1}{3}$. such partes as A F, containeth 90. vz. A E. and then opening my cõpasse I draw the arch or semicircle C E D, which is the circle of Apolloes longitude, vz. of the 14. 20 of ♋. After this from A towardes D, I ame 17. suche partes as A E, containethe $21\frac{1}{3}$. or A F, 90. and there I set M, or make a starre, for there is the place of Apollo, according to his longitude and latitude, then in the arch C E D, frõ E towards the North pole D. I set by ame $9\frac{2}{3}$. of such like partes being the latitude of Orion, vz. in N: and so are these knowen starres placed: which done, I open my compasse as neere as I can gesse to 31. degrees $37\frac{1}{2}$. min. of such like parts, vz. the distance taken by the crosse staffe betweene Orion and ♂, and set the one foote in Orion, vz. M and with the other make a blinde arche cutting the Ecliptick A B, towardes the center: that is to say, with the sequele of the signes, for that ♂ was orientall. Againe I take $10\frac{2}{60}$. lyke partes by gesse, also in my cõpasse: that is to say, the distance taken betwene Apollo & ♂, & setting the one foot in Apollo, vz. N, with the other I make a little blinde arche crosing the first towards the center F also, becausse ♂ was orientall of them both, vz. in O, where must needes haue been the place of ♂, if my figure had beene truly made which for this purpose needeth not but euen slight for a shew. Then with my compasse at the width of A F at the least, I draw the arches M N, M O, and N O, but with no great curiositie: lastly I drawe the arche C O D, which is the circle of the longitude of ♂, and then is my platforme laid, whereupon I descant in this manner.



First to begin with C A, the same is 90. de. and A M, 17. the latitude of Orion: therefore C A M is 107. also C E is 90. degrees by the second def. and N E, but 9. degrees 40. min, the latitude of Apollo: therefore taking N E, out of C E there resteth C N, 79. deg. 20. minutes. Also the angle M C N, being the difference of Orion and Apolloes longitude is knowen to bee 21. degrees 20. minutes by the 4. def. Therefore nowe hauing two sides of the sphearicall triangle M N C, vz. M C, 107. and N C, $79.\frac{20}{60}$. encluding the knowen angle M C N, $21\frac{20}{60}$. degrees, you shal easily by the 13. chap. find both the 3. side M N, to be $34\frac{2}{3}$. deg. and also the angle C M N, to be $39\frac{1}{3}$. Then haue you the triangle M N O, of all three sides knowen. vz. M N. 34 $\frac{2}{3}$. N O, $10\frac{20}{60}$. and O M 31. degrees. $37\frac{1}{2}$. min. VVherefore by the the 11. chapter you shall easily finde the angle N M O to be $17\frac{1}{2}$. deg. which added to the angle C M N, vz. $39\frac{1}{3}$. maketh 57. almost the quantitie of the angle C M O, and yet you will say, what am I the neere for all this. Soft a while, not too fast for falling: nowe are you past your *Inuentum primum & secundum*, which in Synicall workyng, perhaps would haue myred you twise ere this, & yet you scant half way ouer. VVel then to the *inuentum tertium*, you haue a third triangle vz. C M O, whose two sides C M, 107. and M O, 31. deg. $37\frac{1}{2}$. min. are knowen, containing the knowen angle C M O, 57. degrees: wherefore by the 13. chapter you shall easily finde the side C O, $88\frac{3}{4}$. degrees, which take out of C P, vz. 90. leueth O P. $1\frac{1}{4}$. degrees, the latitude of ♂. You shall likewise by the 13. find the quantitie of the angle M C O, 26. degrees, which is the difference of longitude of ♂ from the said great star of Orion, and in reckoning forwardes according to the sequele of the signes: that is say, from the 23. de. of ♊ being the longitude of Orion 26. degrees forwardes on the Ecliptick, falleth out too bee the 19. degrees of ♋, the longitude of ♂ desired: and so is this busie matter at the last brought too good passe by the singuler vse & help of sphearicall triangles, & thus shal you be able to performe any other matter of the sphere whatsoeuer, for you shall not lightly finde any question so harde, but if you once drawe your platfourme you shall deuise how to adde some arches or angles, yeelding sufficient helpe too accomplish your pretence, and many times after you are a little exercised, you shall set your platfourme more expresly by the lineamẽts of your *Iewel*, then with your pen, *Vsus promptos facit, fœmina ludificantur viros*: but tarry, I had almest forgot the declination and right ascension of ♂, for which you had neede make another platfourme, as heere you see A B C D, is the great circle or colure cutting the ecliptikes poles G H, and the poles of the worlde A B, C D: the Equinoctiall K L, the ecliptick R S, the circle of Mars his latitude, and G O PH, of his longitude: G A. is the distãce of the clip. poles frõ ♄ poles of ♄ world vz. $23\frac{1}{2}$. deg. A O B the circle of ♂, right ascension: T O of his declination. Now haue you the sphearical triangle G A O, whose side G A, $23\frac{1}{2}$. and G O, $79\frac{1}{3}$. are knowen containing the angle A G O, being the difference of longitude of ♂ from the beginning of ♋, vz. 19. deg. wherefore by the 13. you may easily get the side A O, and the angle G A O, which had, take A O, out of A X, being 90. leaueth O X. the declination of ♂, then take the angle G A O. out of C A D, vz. 180. it leaueth the angle D A X, the difference of the right ascension between ♂, and 0. in ♋, so that the right ascension of ♋, being alwayes 90. of Mars, it was more at that time by the arch D X.

The conclusion of this worke of triangles.

I Am not ignorant that the Synycal working is moſt exact, & that this maner of working triãgles, thogh on a *Iewel* of two or three foot diametre made of purpoſe is to ſmal effect, for the calculations of the motions of ſtarres, planets, comets, and ſuch like, *Phainomena* of parallaxe, or any other Aſtronomical or coſmographicall operations, requiring exactneſſe vnto minutes, ſeconds, &c. Yet by a great quadrant mixte of the lineaments of Gemma Friſius, and I. Roijas aſtrolabes, which I haue alreadie contriued with his furniture, and meane in my next edition to publiſh, I will ſerue that turne euen vnto minutes and ſecondes, very ſenſiblie and in ſmall angles almoſt vnto tenthes, if neede bee. VVhiche as I doubt not but it ſhall ſerue the vnlearned practiſer as effectually, as the Synycall woorking doth too the learned, ſo I hope by meanes of the eaſie perfourmance, it will greatly helpe and encourage many willing and forwarde wits hereafter to proſecute rare inuentions and concluſions, for diuers Aſtronomicall and Coſmographicall matters, who before tyme haue been ſtalled and myred with the tedious ſcience of Synes, and their appurtenances: beyng indeed as I may terme it, another kinde of Geometrie, and a darke and intricate art. In the meane ſeaſon let no man reiect this 5. booke, which of it ſelfe is highlie to be accounted of: as well in that it is a moſt needfull introduction to that which hereafter I meane to ſet foorth. As alſo for that all the concluſions which I haue written, and hereafter ſhall write of this my *Iewel*, may be wholy perfourmed by it: ſo that this firſt booke might be an abbreuiarie to them all after they are thorowly learned and graft in minde.

The ſixt book of the Mathematicall *Iewel*, newly compiled, deuiſed, and ſet foorth *by* Iohn Blagraue *of Reading, Gentleman: ſhewing the* Theoricall reaſon and grounde of all Dialles and Horizons, and the practicall making of all ſortes of horizontall, murall, declining, reclining, and inclining *Dials, by the onely helpe of this Mathematicall* Iewell, *and that moſt plainely*, readilie, and exactly, as hereafter ſhall followe: which worke, beſides the art of Diall making, bringeth a man acquainted with the full vnderſtanding of the ſpheare, and is the dore into the ſame.

Chapter 1.

Of certaine prenmbles to bee noted in vnderſtanding this worke following.

HOw profitable, how pleaſant, & how neceſſary dials are, there is none ſo ſimple a ſoule but ſeeth it, neither any I thinke ſo ſottiſh to ſay againſt it, ſince no order could be kept in things, if diſtinctiõ of times were not. For what is the cõſeruation, grace, & vpholding of all good ordinances, but euery thing to be done in his due houres. The trauailer by land is not a little cõforted, whẽ he may with a ſmall toy ſee how the day goeth away before him: and alſo may ſee to what place he may reach before nyght ouertake him. The Seamã without dials, or ſuch like inſtrumẽts to know their houres and times, coulde not trauaile at all. Chirſte himſelfe made often mention of houres and times. Therefore ſince their commodities are ſo manifeſt, no doubt but the inuentours were much to be accounted of, and the inuention highly to bee eſteemed. Some will ſay what then? VVhy ſhould wee nowe bee troubled with more bookes thereof, ſince ſo many are alreadie extant, a man may haue too much of his mothers bleſſing. But yet ſir, if you will follow mee, I may happily leade you a pleaſant path, where others are ſtumbled with many a ſtile, and were it not that my worke doth for eaſe ſpeede, and plaineſſe excell all the authours that euer wrote heereof, yet wonlde I not leaue it out, becauſe it wonderfully ſetteth foorth the ſinguler vertue and efficacie of my *Iewell*, which as I haue often ſayd, & manifeſtly ſhewed, will needes ſupply all vſes of Aſtronomie. For as hee hath in the laſt booke made ſmooth all the rockie intricacie of ſphearicall triangles: ſo heere with no leſſe ſingularitie he expreſſeth the making of thoſe Dials, which all other Authours haue left lyke a Labyrinth to the learner, as if you reade Munſter Orõtius and others, and eſpecially Andreas Sconerus, of declining or reclining Dials, you will confeſſe. VVherefore I doubt no but this woorke of myne ſhall bee both acceptable too the beſt, & longed for of the reſt, of which I am too prepoſe theſe preambles following.

1 The whole Globe of the earth in compariſon to the circuit of the ſpeere, wherein the ſunne is carried bea-

eareth a very ſmall bigneſſe, but a centre pricke to ſpeake of, and in reſpect of the other heigher, as the 8. 9 and 10. ſpeeres, it carieth no acount at all. For which cauſe all Dials are made, euen as though we dwelt in the centre of the earth. And betweene a flat heere on the circuit of the earth, and a flat cutting the centre of the earth, ſo they be parallel, there is no difference in this behalfe.

2 All plaine flats whatſoeuer and howſoeuer they decline, recline, or incline, doe repreſent ſome one horizon in the world.

3 Euerie Horizon whatſoeuer, repreſenteth a great circle of the ſphere by his definition.

4 Euerie great circle hath his two poles, euen as the equinoctiall hath by the 2. definition.

5 The poles of any horizon are his zenith, and his Nadir.

6 But to auoyd confuſion of vnderſtanding henceforth in this worke of Dyals, when I ſhall ſpeake of the pole or poles, I will meane onely the pole or poles of the world.

7 And when I ſpeake of the Zenith or Nadir, I will meane it ſimplie for the Horizon of the place wherof I ſpeake, as the common order of ſpeech is.

8 And for that the poles of any Horizon repreſented by any wall, bancke or flatte whatſoeuer, are in truth the Zenith and Nadir of the ſame horizon, therefore I will call the vppermoſt the pole Zenith, and the vndermoſt the pole Nadir of any ſuch horizon, wall, bancke or flatte.

9 Euery Flat whatſoeuer imagined hath two faces, as I may call them, on ech ſide one, as in a Counter, (which though it be a ſolide and ſorie *ſimile*) the one face is croſſe, the other pile.

10 In euery great circle there is a flat to be imagined of two faces, or two flats I might ſay, reſpecting ſeuerall parts of the heauens: as for example, If you imagine a flat in the equinoctiall circle, the ſame ſhall haue two faces, the one reſpecting the North Pole, the other the South Pole.

11 You ſhall finde no great circle of the Sphere howſoeuer imagined, but that looke how much the north pole is eleuated aboue his one flat, ſo much is the ſouth pole eleuated aboue his other flat, or rather depreſſed, to ſpeake it more aptly to my purpoſe, and ſo contrariwiſe, which on your *Iewel* you may moſt euidently ſee. For placing the *Finitor* to our latitude vz. $51\frac{2}{3}$ degrees fixed vnder the north pole, you ſhall ſtreight ſee the ſouth pole depreſſed $51\frac{2}{3}$ deg. vnder the *Finitor*, which is the eleuation of the ſouth pole to thoſe people which be Antypodes to vs, an ſo forth in any other latitude.

12 Sythens euery flat whatſoeuer repreſenteth ſome one horizon in the worlde, and euerie horizon ſome one great circle of the ſphere, as is before ſaide: therefore euerie flat not being a right horizon, lieth in ſome one great circle, aboue which one of the poles is eleuated, hauing alſo an other Antypodall flatte imagined on the backſide, vnto which the other pole is as much depreſſed, or to ſpeake it Antypodally I may ſay eleuated: for you muſt note that euery right horizon hath neither pole eleuated as ſhalbe ſhewed.

13 In euerie latitude you ſhall finde both the poles to be eleuated aboue the flats of the Verticall circle, or Eaſt Azimuth (which repreſenteth alwayes the North and South wals) as much as the latitude lacketh of 90. As for example, ſet the *Finitor* to our latitude videlicet $51\frac{2}{3}$: you ſhall ſee that the zenith line which alwayes repreſenteth the ſaid verticall circle hath the North pole eleuated $38\frac{1}{2}$ deg. aboue his one flatte, and the ſouth pole as much aboue his other flat.

14 Note that when you finde this word (Latitude) ſimplie in this 6. Booke, I meane the Latitude of the place where you remaine, and that to all other walles and flats, I will vſe this word Eleuation, or poles Eleuation for diſtinctions ſake.

15 Alſo I wil vſe this word Horizon ſimplie but to the place of your biding, the reſt I wil cal wals or flats when as I meane the Horizons or great circles repreſented by them.

Chapter 2.

Of the diſtinction on Dials into two kinds, Inſtrumentall and Spherical.

THe ſhapes, formes, faſhions, and deuiſes for Dials are very many in generall: yet in particular they are but of two ſorts, for either they are made to deſcrie the houre by the altitude of the ſunne, of which ſort are Quadrants, Rings, Circles, Shippes, Cilinders, and ſuch like: and therefore rather to be called inſtruments then Dials: Or elſe they are to ſhew the houre by the ſhade of a cocke, ſtile, or Gnomon without reſpect of ſunnes altitude, of which ſort are your common Horizontall and Murall Dials of all ſorts: your portable Dials with needles: your Equinoctiall, your conuex, concaue, and ſuch like.

Of the firſt ſort the deuiſes are ſo manifolde, which euerie learned Aſtronomer may and hath deuiſed to his fancie, that a great volume would not contane them. VVherefore ſince they be trobleſome and buſie to make, and being made ſeldome ſerue but to one latitude, and withall cannot be vſed but of the learned ſort: I do not meane to entreate any whit of them, but will ſet ouer thoſe that are deſirous of ſuch fancies vnto Munſter, & Orontius *de horologiis*: to Apian, who hath made a buſie Horoſcope: to Sconer, not inferiour to any of them: to Stophler, and ſuch ancient writers, where they ſhall ſee deuiſe ynough to werie them. And the rather I omitte theſe inſtrumentall Dials, becauſe all their vſes are farre more reddily performed by my *Iewel*: Yet knowne that the vnderſtanding of my *Iewel*, ſhall cauſe any man almoſt at the firſt inſpection to make any of them: for the onely and chiefeſt matter in their fabrication dependeth on the knowing of the Sunnes true altitude for euery houre through the yeare: which by my 3. Booke 31. Chap. is had for the looking on. And ſo I leaue all Dials of that ſort, to them that like better of them then euer I did. For I neuer loued to carie a Diall about me, whereon I muſt bee driuen to hunt after the houre when I had neede of him: which minde of mine, was the onely cauſe that made me to deuiſe the furniture of the *Iewel* as you ſee: For that as I haue often ſaid by Gemma Friſius, Regula, Curſor, and Brachiolum, I could get nothing without hunting after it, and ſomtimes the Curſor led me ſuch a courſe that I haue beene faine to giue ouer the chaſe, or not fully purſued it to the very point. Thus much of inſtrumentall Dials. The ſecond ſort which are more aptlie called Dials, I meane at large to proſecute in this volume, becauſe they depende altogither *Ex protractione Sperica*, as

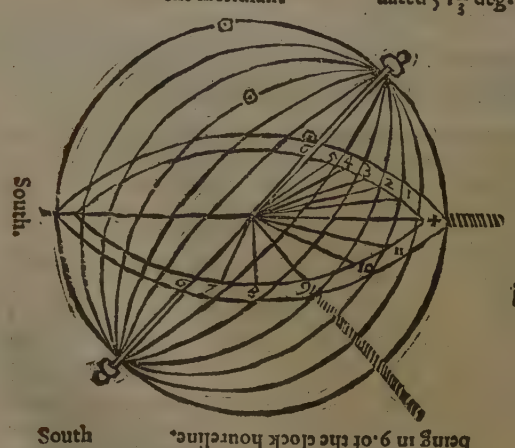
vses, as in the next Chapter appeareth, and make not a little to the liuely vnderstanding and wonderful vse of my *Iewel*. In latin they are called *Solaria* or *Instrumenta Scioterica*, also *Horologia* of the greeke word.

Chapter 3.

Of the definition and deriuation of Dyals and the grounde of them all.

A Dyall in verie trueth, might be called a plaine sphere: but onely that it wanteth parallels: for the lines drawne thereon to distinguish the houres, are the verie meridians or hourelines of the sphere prospectiuely proiected on a plaine *Superficies*, by the Sunnes accesse vnto them: as here following I wil as much as I can, make manifest, bicause the most part will hardly beleeue it. But first to define an oblique Dyall which chiefely commeth in question more artifically: An oblique Dyall is most commonly a rounde *Superficies* or flatte, lying equiballance to some one horizon, concentricke to his circumference, from whose centre, issue out certaine streight lines, vnto the intersections of euerie 15. meridian or houreline of the sphere with the Horizon: cutting also the circuite of the same Dyall flatte, into like and proportionable parts vnto the saide intersections of the Horizon. For the plainer demonstration of this definition, take my *Iewel* in your hand and set the *Finitor* to the equinoctiall, which representeth an Horizon where one of the poles is Zenith: now if in this horizon you imagine a rounde plate to make a Dyall on: the same must needs be equiballance, and concentricke, both to the equinoctiall and *Finitor*, bicause they are in this constitution of the sphere all one circle: and for as much as the parallels grow lesse and lesse, euen vnto nothing at the pole, and that the pole is here the zenith, therefore it must needes be that some one of these parallels is equall and equidistant, to this round plate for your Dyall, so that a perpendiculer line let downe from the zenith or pole, shall cut the centres both of the Horizon, parallel, and plate. Then who knoweth not that the equinoctiall, and likewise all the parallels are deuided into 360. equall parts by the meridians of the sphere, of which 360. the 24. part is 15. therefore euery 15. meridian are commonly called hourelines. These hourelines (or rather spherically called houre circles) doe nowe deuide the *Finitor* in this constitution into 24. equall and euen parts: wherefore if you imagine 24. lines issuing from the centre of the *Finitor*, (which is also the centre of the Dyall plate, and represented here by the centre of the *Iewel*) vnto the 24. intersections of the said houre circles with the *Finitor*: they shall deuide the Dyall plate into 24. equall parts, bicause the intersections in this horizon are equall, euen as the parallel that standeth directly ouer the plate is deuided: so that by this definition you may conclude that a Dyall, made to that Horizon, where the pole is zenith, is onely a circle deuided into 24. equall parts which is called an equinoctiall Dyall.

As this demonstration is most manifest in the equinoctiall Horizon, where the saide 15. meridians cut the Horizon into 24. equall parts: so falleth it out plaine ynough in any other horizon, where one of the poles is eleuated aboue the same otherwise howsoeuer. For euery such Horizon, is also deuided by those selfesame 24. meridians, into 24. partes, but vnequall: and by how much lesse the pole is eleuated, the more vnequall they are. For demonstration whereof, set the *Finitor* of the *Iewel*, vnto our latitude here at Reading, viz. 51 $\frac{2}{3}$ deg. vnder the pole. Now to see the proportion of the spaces for the hourelines of a Dyall to the same Horizon, marke how the 15. prickt meridians or houre circles of the *Iewel*, doe cut the *Finitor*, for if you tell the degrees on the *Finitor*, betweene ech cutting you shall haue thereon the degrees seruing to the seuerall distances of the hourelines of your Dyall, so that if as before, you situate in this horizon, a rounde plate for your Dyall, the same shall be concentricke thereto, and equall to one of the Almicantares, which grow lesse and lesse to nothing at the zenith, euen as the parallels do at the pole, wherefore if from the centre of your plate you imagine 24. lines issuing vnto the intersections at the worlds end, as they say, of the 24. houre circles with the *Finitor*, they shal cut the round plate into 24. like vnequall parts vnto those, made on the horizon or *Finitor* in all respects proportionably an Symitrially agreeing, so that whither your Dyall plate be great or little, his diuisions are proportionable.



For better explanation heereof vnto the young learners: admit that you had 24. wyers, of equal length, made iust semicircle-wise, and all of them ioyned at two points or poles: these 24. wyers being set ech of like distance from other, would make 12. whole circles: whereof you might appoint any one of them for the meridian circle, then if you did prepare a round plate, or thinne boorde, with a hole in the centre, of equall circuit to one of these 12. wyer circles, and did put him within these wyers, like a bird in a kage, but so that the one pole where these wyers meete, might be iust 51 $\frac{2}{3}$ deg. reckoned on the meridian wyer aboue this plate, and the other pole as much vnder: and lastly thrust a streight wyer through both the same poles, & the centre of the plate,

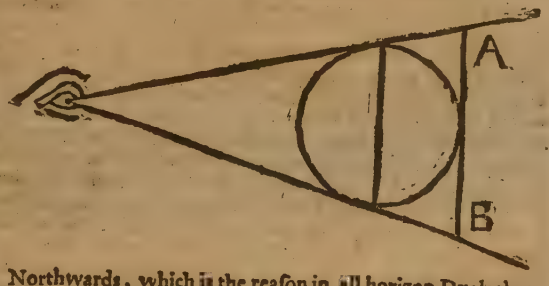
plate, as in this figure appeareth: you haue a plaine ocular demonſtration of the grounde and reaſon of al Dyals, for if now you faſten a threede at the centre of the plate, to the axtree line: or elſe a ruler, and lay the ſame from place to place, where the 24. wyers do touch the round plate, you may thereby drawe the houre lines for your Dyall, as many as ſhall ſerue your turne, as I haue done in this figure, which hath but 12. houre circles, or wyers here repreſented, becauſe the whole 24. could not wel be drawne, but the other 12. you muſt imagine to lie ſo oppoſite and directly one to another, that euery one hideth his match. Now if you place this plate within the wyers, neere or farther off from the pole, according to the latitude of any countrie whatſoeuer: you may thereby make a Dyall thereunto. So that a man might make a pretie inſtrument of 24. wyers, to make all manner of Dyals by, if there were no other ſhift, but you ſhall haue my *Iewel* about you when the wyers will be to ſeeke, neither can the wyers be exactly bent true compaſſe, nor being bent, keepe their iuſt places long.

Chapter 4.

What the cocke or Gnomon of euery Dyall is, and by what reaſon they giue the true ſhade to the Dyall.

FIrſt you ſhall vnderſtande that the cocke, Stile, or *Gnomon* of euery Dyall, I meane the line thereof that yeldeth the ſhade to know the houres by, lyeth directly in the axtreeline of the world, or at the leaſt, parallel vnto him, which worketh the ſame effect.

Secondly I ſhewed in the laſt Chapt. that the ſphere is ſet about with 360. houre circles, meeting at the poles: which maketh 24. times 15. whereby the ſpace of time, wherein the ☉ commeth vnto euery of theſe 15. by the motion of the *Primum mobile*, or firſt mouer about the axtree of the worlde, maketh one houre: So that an houre is the 24. part of this reuolution once about. Theſe 24. houre circles of the ſphere are repreſented in the laſt Chapter, by 24. wyers, of which, euery one is ſo directly oppoſite to his match againſt him, that they both make one whole circle. Inſomuch that of the 24. houre circles, or rather ſemicircles, (as they are in deede) there are made 12. whole circles, meeting and croſsing ech other in halfe at the poles: wherefore of neceſsitie the axtree muſt needes be dyametre to them all by the firſt definition, and firſt *Theoreme* of the fifte Booke. This knowne, I thinke there is no man ſo ignorant, but may conceiue without the 22. Theoreme of Euclides proſpectiue: that if a circle with his diametre or axtree, be turned edgelong towards a mans eye, that then it appeareth to ſight no circle. but a ſtreight line like vnto A B in this figure. By this onely proſpectiue reaſon it commeth to paſſe, that the axtree line giueth ſhade vnto the Dyal. For when the Sunne is in any houre circle, the ſhadowe of the axtreeline is extended thereby directlie on the houre circle oppoſite to the ſame, and by that meanes ſheweth the houre. As for example, if you place the inſtrument of wyers mentioned in the laſt Chapt. ſo that the round plate encluded within them, may ſtande equiballance to the horizon, & the meridian wier, directly North and South, the pole aboue the plate Northwards, in order ſpherically: you ſhall then ſee that the Sunne being in the meridian circle Southwards, ſhall caſt the ſhadow of the axtree line directly on the ſame meridian Northwards, which is the reaſon in all horizon Dyals that haue trianguler cockes, they giue no ſhade at 12. of the clocke. Likewiſe the ſunne being in the 9. of clocke houreline, caſteth the ſhade of the axtree line directly on his oppoſite, being the 3. of clocke circle: in ſo much that in your inſtrument of wyers, you ſhall perceiue that at euerie compleate houre, the ſame houre wyer with his oppoſite, and the axtree, will all three giue but one ſtreight line for ſhade, which ſhall be directly on the houre line, drawne one the rounde plate for the ſame houre. Inſomuch, that by one Dyall exactly made, a verie rude and vnskilfull man may make any like Dyall, if the cocke were ſet vp to his hande, for at euerie houre his ſhade will moſt truely expreſſe the houreline, and ſo for a ſhift he might make a Dyall in a day: if the Sunne chaunce not into a cloude: then he muſt tarie the Lords leiſure. This matter is expreſſed in the figure of the laſt Chapter.



Chapter 5.

Of the diuiſion of Horizons, and eſpecially into three ſortes.

ALthough that euerie leaſt declining of anie wall, flatte, bancke, or buttreſſe, is particulerly a diuerſe horizon, by the firſt preamble: and hath a ſundrie eleuation of one of the poles, or none at all, ſo that in this ſenſe the horizons be infinite: yet by two other meanes they are brought to a farre leſſe number: whereof the greateſt is 90. and the leſſer but two. For as in all Aſtronomicall workings 90. horizons ſerue through the world, euen as I ſhewed in the 2. Booke and 21. Chapter, the reaſon is, as I there ſaid, becauſe he that coulde go continually vpon one of the poles, ſhall finde that when the pole is once 90. deg. eleuated, hee then is at the heigheſt, euen in the zenith: then let him go on ſtreight he ſhall ſee him ſinck againe on the other ſide of him. So alſo in another ſenſe, they make but two differences videl. *Horizon rectus*, and *horizon obliquus*, yet ſome make three, which I for diſtinction of my Dyals thinke beſt of, vz. *Horizon rectus* or *Polaris*, *Aequinoctialis*, and *obliquus*. *Horizon rectus* or *Polaris* a right or polare Horizon, they will to be where the Aequinoctiall in zenith, and the poles leuell with the Horizon, neither of them appearing aboue: and

and for as much as all the meridians meete at the poles, therefore euerie right Horizon muſt needes be, and lie in one of the meridians, for that there are no circles of the Speere, whith haue their pole Zenith, and Nadir in thequinoctial, but onely the meridians as I partly ſhewed in my 24. Chapter of triang. Wherefore to conclude, euery Eaſt or VVeſt wall, are right horizons becauſe they lie directly with the meridian, and ſo are any other reclining or inclining wals or flats, cutting either poles, that is to ſay aboue which neither pole is eleuated.

Horizon Equinoctialis the Equinoctiall horizon, is where the pole is in the zenith, and thequinoctiall become all one with the horizon, ſome write he is *Horizon obliquiſſimus*, becauſe the ſignes and the ſtarres in this horizon do go all a ſlope as though they went round about the ſide of an hill. But if my opinion might ſerue for authoritie, I would call this Horizon *Polaris*, for that the pole is zenith; and the other *Equinoctialis*, for that thequinoctiall is there zenith: my reaſon is becauſe the denomination of any thing ought to proceede from the worthieſt part of it, which muſt needes be the highermoſt, for the ſtarres and planets haue moſt power and force when they are in the heigheſt part of the heauen, alſo the Zones, Clymats, and Parallels take their names of thoſe parts of the Sphere, which are in the Zenith, for it were abſurde to ſay that a man were in the hot zone, when thequinoctiall is the Horizon, where he ſhould finde himſelfe in the coldeſt.

Notwithſtanding I will yeelde in this behalfe to the authoritie of all the learned men that haue written, rather then preſume to offer to ſtande in armes againſt them, knowing my validitie too weake to encounter them: yet hereafter in this worke, I muſt craue leaue of them to terme euerie wall and flatte, by the place where his pole zenith lieth as a ſouth wall, to be a flatte, whoſe pole zenith lieth in the ſouth point of the horizon, and ſo of the reſt.

Horizon Obliquus, an oblique Horizon is where one of the poles is eleuated how much or little ſoeuer, till it come to 90. degrees.

Chapter 6.

Of the diuiſion of all Dials into three ſorts, and whie they make ſhew of greater diuerſitie then there is.

IN the laſt Chapt. I diſtinguiſhed all horizons into three ſorts, and that for two cauſes: the one, for that the formes of making all manner of Dials is but of three ſorts, as ſhalbe ſhewed in the next three Chapt. therefore marke them well, make thoſe and make all the other: for that the dials to euery of thoſe Horizons require their cocke or *Gnomon* of a ſeuerall forme. For the dyals of all flats lying in any right horizon, haue their hourelines parallel one to another, and their cocke a long ſquare, although ſome vſe a ſtile or wyer, which is not ſo good nor ſo agreeable to the nature of the diall: becauſe the ſtile muſt be of a iuſt determinate length: and then can yelde ſhade to the Dyall but from the very toppe: whereas the long ſquare cocke yeldeth a long line for ſhade, and the ſame alway parallel to the hourelines, and like vnto them. The Dyals of all flats lying in thequin. are but a circle deuided into 24. equall parts, the hourelines meeting at the centre, whoſe cocke or *Gnomon*, moſt commonly is a ſtile or pin erected: neither is it materiall how long or ſhort hee bee. The Dyals to all flattes lying in any oblique or byas horizon, are a circle deuided into 24. vnequall parts, the hourelines concurring at the centre, whoſe cocke or *Gnomon* muſt needes be a triangle, his ſide yelding the ſhade to the Dyall, eleuated in height according to the poles eleuation: though ſome barborouſly, as I may terme it, vſe a wyer bent a ſlope to the poles height, which euery bird almoſt with ſitting on it, may way from his pitch, and then all is marde till ſome ſkilfull man come to mende it, becauſe euery man knoweth not what the height of the pole meaneth. For I remember well I asked a cunning gardiner once, that had ſet vp a poſt aſlope in a curious Garden in the middeſt of a circle, what he would make: a Dyall (ſaid he) why? ſaid I, how heigh is the pole here, ſaide he ſixe foote heigh, pointing to the poſt that himſelfe had ſet vp: whereat I laughed hartely ſeeing ſo cunning a peice of worke towards: but now againe to my matter. As there are but three diuerſities of Dyals and horizons, ſo are they eaſily to be made in euery country, whervnto they ſerue without any difficultie, if a man were in euery ſuch place ſeuerally, by occaſion of trauaile or otherwiſe. But yet to make the Dyals, which of right ought to ſerue in other countries, to ſhew the houres and ſerue your turne in your owne countrie, maketh a great ſhew of skill, and of diuerſe ſorts of Dyals, to thoſe that vnderſtand not the cauſes of them. For the murall declining, reclining, inclyning orientall and occidentall Dyals and all others, the plaine horizontall excepted, are dyals which of right belong to other countries, and horizons, and are but wreſted as it were to ſerue altogether to one place: neither is there any of them but is one of the three ſortes before mentioned. There is none of them but of right ſerueth to a countrie, differing from yours, either in longitude, or latitude, or both: but eſpecially the difference of longitude maketh this great diuerſitie and difficultie, for that onely driueth vs to alter the true courſe of the hourelines, and their numbers to make them ſerue in our countrie. As for example, in an Eaſt Dyall, in the place where the cocke ſtandeth he ſheweth no ſhade, and then is it 6. of the clocke in our countrie. but to that countrie whoſe difference of longitude is 90. deg, Eaſtwards, or more plainely whoſe pole zenith is in theaſt point of our horizon, it is then 12. of the clocke, and ſo would it giue alſo in our countrie, if you laide the ſame Dyall ſo that his pole zenith may be in our meridian, his flat cutting the poles.

Likewiſe in the declining Dyals here in our countrie, the perpendiculer is alwayes 12. of the clocke: but in the horizon or countrie whereto the Dyall ſhould ſerue, the 12. of clocke is iuſt where the cocke ſtandeth, ſo that it is a general rule if you ſee any Dyal, his cocke yeelding no ſhade at 12. of clocke: that the ſame is made to the longitude of the ſame place: wherefore to conclude my purpoſe, there are but three diuerſities of Dyals, onely the ſituation and change of the place maketh the alteration.

Chapter

Chapter 7.

How to make the first kinde of dial to the Equinoctial horizon, that is, where one of the poles is zenith.

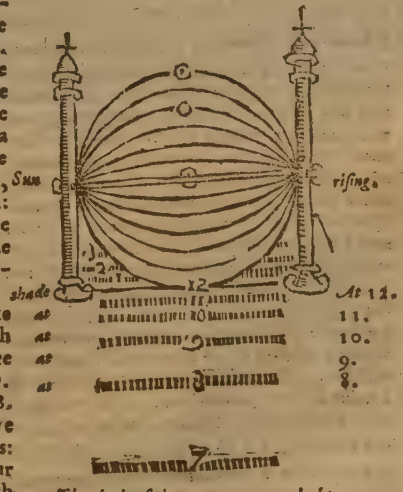
THe matter is short and already sufficiently to be had by the 3.chap. deuide a circle into 24. equall parts frō the centre, drawing the houre lines vnto them, then set to the figures frō 1. to 12, & thence from 1. to 12. again, to make vp 24. it is no matter where you begin to number, so you make an end wel: if you would needs make this dial by the *Iewel* in the 3.chap. you haue instructions sufficient, the cocke is but a stile or wyre erected as plum as may be from the flat, so that the top be no neerer to the one part of the circle then the other. This diall though he be sleight can least be spared, as the shipmen can witnesse, which with a quadrant annexed behinde him, serueth in euerye latitude where the ship goeth, a thing moste common, or els I would spend sometime about it, if you know it not, look *Orontius* & *Munster de horologijs*, or in English the Art of nauigation and the regiment of the Sea.

Chapter 8.

How to make the second kinde of dial to a right horizon, that is, where the Equinoctiall cutteth the zenith, together with the ground and reason of al dials to any right horizon.

I shewed in the 3 and 4.chap. the reason of making all dialles to any horizon, where any one of the poles is eleuated to come of the intersection of the houre lines, with the horizō. And by example of wyres the same conclusion, & withal how that the axtree did after a sort delineate out the lines of all dialles, by his shade. But now in a right horizon where neither of the poles are eleuated, because the Zenith is in the Equinoct. one of the meridians must needs be the horizon: & of the rest of the meridians, the one halfe be alwayes wholly aboue the horizon, & the other half vnder, they al cutting the horizō together at 2. points, which are the poles: which is the cause that they distinguish not the houre lines of the diall by their intersection of the horizon, as in the Equinoctial, and obliqne horizon, but yet by helpe of the axetree, they wil do it here as wel as in them, and that in this manner. Take your 24. wyres spherically conioyned, as in the 3.chap. and erect the meridian wyre perpendiculer on some plaine flat, so that the axetree wyre may be parallel to the flat as in this figure you see. Now if you were vnder the Equinoctiall, or if you erect one part of this flat, so that the poles & axetree of the wyres thus placed, may lye leuel with the poles of the world: that is to saye, in your meridian according to the poles eleuation, you should then see the Sunne at his rising, to cast the shade of the 6.a clocke wyre, and the axtree wyre directly on the other 6. a clocke wyre: that is to say, parallel to the flatte: so that the dialles vnder the Equinoctiall haue no houre line for 6.a clocke. But after that the Sun rising to 7. a clocke, doth cast the 7. a clocke wyre, the axetree wyre and the other against him, al three in one shade, making one streight line equal to the axetree wyre, & may serue for the 7. a clock houre line, if he be not before drawne. Likewise at 8.a clocke, the 8. a clocke houre wyre, the axetree and the other against him, yeelde al three but one streight line for shade: which sheweth 8.a clock, and so at 9. 10. 11. and then at 12. the Sun is directly ouerhead: which would cause the Gnomon or axetree if hee were a longe square, to yeeld no shade: then the Sun by his comming down describeth the after noon houres, as by this figure I hope you plainly conceiue.

A right Horizon.
Sun in the meridian.



The shade of the axetree at 7. a clocke.

This wel vnderstood, you may make the dial easily thus: Take a long square stone or flat: and crosse him in the middest both wayes with two lines square ech to other; let the longer line bee East and VVest, videl. A B: the other North and South, vz. C D. Then erecte your *Iewell* perpendiculer on this East line A B. and directly with it: but so that the plum line of the *Iewell* maye stand perpendiculer thereon, in the crossing of these two lynes: and there deuise by some meanes to fixe him: that line of your *Iewel* so fyxed, set your rule with sightes to the line of *Leuel*, which is then parallel to the stone or flat, and representeth 6.a clocke in any countrey where the Equinoctial is Zenith, then lift vp the end of the ruler, vnto the next 15.deg. of the *Limbe*, and looking through the sights, mark with a pen (as you may easily doe) where your eye beame doth point on the said East line, there draw a lyne square ouer the stone for the 7.a clock houre line, that done, lift vp the ruler other 15.deg. and there marke with a pen where your eye pearcing the sightes, doeth pointe on the sayde lyne, drawing there also another crosse line, for the 8.a clocke houre line, and so doe with euery 15.degree of the *Limbe* of your *Iewel*, in the vppermost halfe, vntill you haue done, as in this Figure you may beholde. Also you may if you list lay the *Iewell* flat vpon the stone, so that his plumbe line lye direct with the crosse line C D, and his *Limbe* touching the East line A B and then fyxing a threed in the centre of your *Iewel*, leading about the same from 15. degr. to 15. deg. of the *Limbe* with your hande, and at euery place where this threed doth cut the East line, there drawe lines crosse the stone ech parallel to other, and square to the East line: then set numbers thereto as in this Fi-

gure you may see. The cock or gnomon to this dial must be a lōg square like vnto G, erected in the 12. a clock line, whose length is commonly vsed equall to the line C D, or it may bee lōger or shorter at your pleasure, but the height must needs bee equal vnto the space betweene the centre of the *Iewel*, & the line A B. Thus maye you note that whether your *Iewel* stande perpendiculer on the flat, or lie down theron the crosings of the long line A B, which some call the touch lyne are al one: so that the leuell line of your *Iewel* be parall. to the touch line.

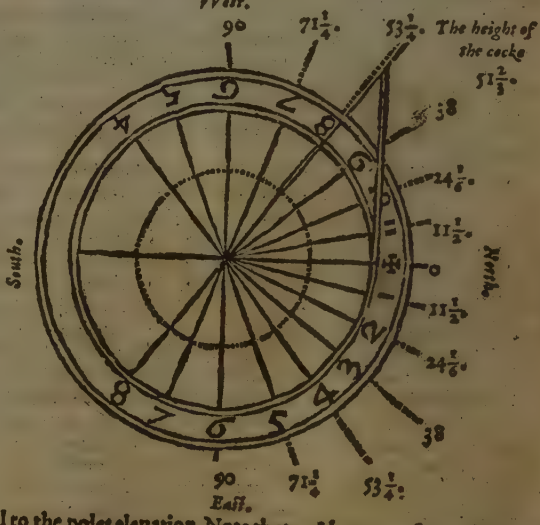
The Iewel *eyther erected to the eye or depressed to the flat.*
The cocke or Gnomon.

Chapter 9.

How to make the third kind of diall to an oblique horizon, which they commonly cal an horizon diall, and that very easily.

WHen you come into any countrey, where you would make a dial: first you must get the poles eleuation or latitude, thereby the 3. book 5. & 8. chap. & if you fynd the pole eleuated any whit, then you may be sure it is an oblique horizon: to which if you wil make a dial, set the *finitor* of your *iewel* vnto the same latit. found where you shal see the *Limbe* or vttermost meridian of your *iewel* and the axetree or East houre line, to cut the *finitor* 90. deg. or one quadrant apart: which is the cause that in an horizon diall, the first point is to deuide the circle into 4. quarters. Furthermore, if you behold your *iewel* wel in that scituation, you shall see, that the houre circles, (I meane euery 15. meridian) on the one side of the axetree line, doe cut like equall degrees on the *finitor*, vnto the houre circles on the other side, eche to his matche, beeing both reckoned eyther from the seueral vttermost partes of the *Limbe* or on ech side from the centre: which is the cause, that if the deg. of an oblique diall be knowne for one quarter, all the other 3. quarters are to bee drawne by that: so that by this meanes, the two diameters seruing for the noone line and Eastline being drawne, 5. spaces more knowne shall serue to make the whole dial by: which in my opinion can be no great toile.

Example: here at Reading the latitude is 51 $\frac{2}{3}$. deg. and therefore is an oblique horizon. To make a diall thereto, I get a flat stone or plate, and thereon make a circle, or rather a *Limbe* to the diall: crosing the same square vppon the centre, with 2. lines into 4. quarters, of which lines I appoint one to be the noone line, & at his North end write 12. the other the East line, & ech end write 6. Then for my further ease, because I wold not deuide the *Limbe* of my dial into 360. deg. as *Cor. Gemma* teacheth, I make on the centre of this dial a blind circle, equall to the graduated circle on the *Limbe* of my *iewel*, al which done, I set the *finitor* of my *iewell* to the 51 $\frac{2}{3}$. latitude, and there doe I marke what deg. of the *Finitor*, the 1. 2. 3. 4. & 5. a clocke houre circles doe cut: I finde at 1. a clocke 11 $\frac{1}{2}$. deg. at 2. 24 $\frac{1}{6}$. at 3. 38. deg. almost, at 4. 53 $\frac{1}{4}$. at 5. 71 $\frac{1}{4}$. all of them reckoned on the *Finitor* from the *Limbe* of my *iewell* inwardes: all these seuerall spaces of degrees, I take with a payre of compasses orderly one after other from the *Limbe* of my *iewell*, and set them, or notes for them on ech side of the noon line in the saide blynd circle, beginning from the noone line: and then doe I drawe lines from the centre of the diall, through all the notes in this blind circle vnto the *Limb* of the dial: seruing to the houre lines, as by this figure you may more plainly perceiue. then by many words. To these lines I set these numbers, 1. 2. 3. 4. and 5. on the Northeast side, & on the Northwest quarter: to them these numbers: 11. 10. 9. 8. 7. as you see: then if you draw forth the 4. and 5. houre lines vnto the Southwest quarter: you haue the 4. and 5. houre lines whiche the Sun riseth before 6. in the Sommer time. Likewise drawing foorth the 7. & 8. your dial is made: & for the cocke or gnomon to this diall, if you take the degrees of the latitude, vz. 51 $\frac{2}{3}$. deg. in your cōpasse & sett the same in your blinde circle, drawing thereto a line from the centre, and erecting at the North end of the noon line a perpendiculer to meete him there, you shal haue the iust patterne for your cocke, as in this figure you may behold: for it is a generall rule that the cocke of a diall to an oblique Horizon, whether it decline, recline, incline, or howsoeuer, must be eleuated from the horizon, equal to the poles eleuation. Note that as I haue performed this by one quarter of the houre lines of the *iewel*, you may by the *iewel* perform the whole round: but al commeth to one effect, since as I said the spaces of euery quarter are like, and containe like number of degrees, being taken equally on eth side of the noone line.



Chapter 10.

How to make a diall to a perpendicular wall beholding the South fully, called of some Authors Horologium verticale.

THat wall which I call a South wall, is an horizon, or great circle, whose pole Zenith lyeth in the South point of the horizon of the countrey where it standeth, and lieth euē with the East azimuth of the same place, being all one circle with him. Insomuch that he is on my *Iewell* in euery latitude, represented by the line, which I call the Zenith line, or East azimuth. To this wall the South pole is eleuated alwaies as muche as the latitude of the countrey lacketh of 90. by the 13. preamble, which here at Reading is $38\frac{1}{3}$. degrees, and therefore is it an oblique horizon by the 5. chap. whereto you may easily make a dial by the last cha. only here in it altereth a little, you need make but bare 12. houres: for that no perpendiculer wall in these partes canne serue aboue that compasse, and that you must turne the dial and the cock downwards, that he may behold the South pole, prouiding that the 12. of clocke lyne be drawne very perpendiculer down the wal. For your better vnderstanding, sette the *Finitor* to the latitude of Reading, videl. $51\frac{2}{3}$. vnder the pole, then if you behold the Zenith line, which as I said, representeth the South wall, you shall finde at the Nadir of the zenith line, the south pole to be eleuated $38\frac{1}{3}$. degr. if you reckon towardes the South parte of your *Iewell*, wherefore in respect the Zenith line is graduated as wel as the *Finitor*, you may thereuppon see what deg. euery houre requireth as wel as in the last cha. by the *Finitor*, & so you shall find the 1. a clocke houre line to cutte 9. deg. the 2. $19\frac{1}{7}$. the 3. $31\frac{2}{5}$. the 4. $46\frac{1}{2}$. & 5. $66\frac{2}{3}$. & the 6. alwaies 90. by which make your diall, as in the last chap. and as in this figure appeareth. Note that the eleuation of the wall knowne, you may set the *Finitor* to the same latitude vnder either of the poles, without respect, and make your diall therby, which indeed ie the best course, because the degrees are farre more easily to be counted on the *Finitor*, then on the Zenith line.

A Dial beholding the ful South Zenith.

The height of the cocke $38\frac{1}{3}$ deg. being the South poles eleuation aboue this flat.

Nadir.

Chapter 11.

To make a diall to a ful North wall.

IHaue shewed in the 9. and 10. preamble, that euery perpendiculer wall or flat hath two faces: (that is to say) if a wal be in length East and VVest, then on one side the South beholdeth him full, on the other side the North, insomuch that looke how muche the South pole is eleuated to the South side, so muche is the North pole eleuated to the North side by the 12. preāble, both which the zen. line repereseteth. VVherefore you may conceyue that one diall serueth them both, onely they alter in this: that this diall to the North wall must be turned vpside downe, that the cocke may beholde the North pole, and all the houres saiuing 4. 5. and 6. in the morning, and 6. 7. and 8. at Euening left quite out, because the Sun commeth to a North wall, but before 6. in the morning, and after 6. at euening, as by this Figure you may perceiue.

A Diall to a full North wall.

Nadir.

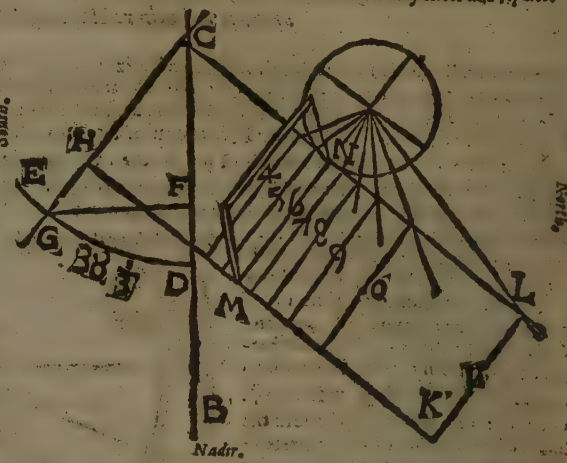
Chapter 12

How to make a diall to an East wall.

AN East wall is an horizon, whose pole Zenith lyeth in the East poynt of the horizon, whereon it standeth, or more plainly an horizon lying euen with the meridian of the horizon whereon it standeth, so that an East wall pointeth directly North and South, whereby you may gather by the 5. chap. that it is a right horizon: and therefore you may easily make a diall thereto, by the 8. chap. only the alteration is in the placing of the diall, and numbering the houres, which you shall thus doe. First drawe a perpendiculer on the wall, videl. A B, then pitching your compasse in some one point thereof most conuenient, vz. C draw a blind

arch Southwards of the plumme line videl. D E, whereon number by deg. the eleuation of the South pole aboue the perpendiculer or Zenith line, videl. D G, which as in the 10. here at Reading is $38\frac{1}{3}$. deg. the drawing a line from that deg. to the center of the arche, videl. G C, and another perpendiculer to the plum line, or parallell to the horizon, all is one, videl. G F, so haue you G F C the verye patterne of the cocke to the South wall diall, and that in his direct situation to eyther pole, his Gnomon line issuing from the centre, videlicet G C, representing the axetree of the worlde, and directly beholding both the poles: wherefore drawe another line square vnto him longe inough for your diall, videl. H K, and the same shall represent the Equinoctiall flatt, to whiche drawe another line parallel as farre dystant as your dial shalbe in width, videl. C L, this done draw a line between the Equinoctial and his parallel, square to them both, euen where you thinke moste conuenient for the cocke to stand, videl. M N, which shall also be parallel to the axetree G C. In this line M N place, the plum line of your *Iewell*, his *Limbe* touching the Equinoctiall line H K or C L, all is one, and there your *Iewell* fastened with waxe, or staied with ones hand, laying a threed to euery 15. deg. of the *Limbe*, extended to the touch line C L, draw your houre lines at ech crossing, so that euery of them be parallel to the axtree line G C, by the 8. chap. But now in an East diall you must number the line where the cock standeth with 6. the reason is for that the meridian of the horizon represented by an East wall is 90. deg. or 6. houres distant from ours: beeing in truth the 6. a clocke houre circle, in our countrey, so that when it is high noone to that countrey whereto our East wall is horizon, it is here but 6. a clock in the morning, the difference of longitude being 90. The rest of the numbers for the houres, sette in as in this figure you may see, because the Sunne riseth to vs neere at 4. a clocke in the morning: therefore I haue set no houres aboue that, and bicause the Sunne departeth from an East wall at 12. therefore past a 11, I cannot goe.

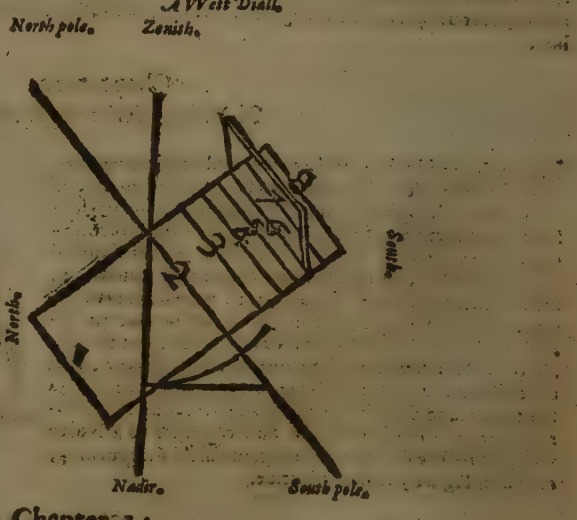
A Diall beholding the full East.



Chapter 13.

How to make a Diall to a West wall.

A VVest Diall.



VVOorke in all respectes as you did in the East wall, sauinge that becausse the Sunne beginneth to come to the VVest wall but at 12. a clocke: therefore you must chaunge the numbers of the houres, as in this Fygure you may better see, then by many woordes vnderstand.

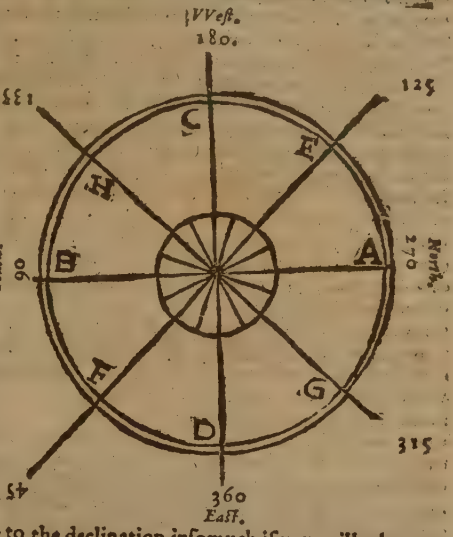
Chapter 14.

Of declining walles, and what circles of the sphearе they represent.

IT is a Maxim in philosophie, (as I haue already said) that *Omne graue tendit ad centrum*, insomuch that if you trauel round about the world with a threed and plummet in your hand, the plummet shal still point vnto the centre of the earth: all vpright walles are made perpendicular by a line and plummet: therefore the great circle of the sphearе lying euen with any wall, must needes cut the centre of the earth, and be concentricke, & a great circle by the 1. def. And becausse euery wall perpendicularly erected, cutteth or pointeth to the zenith, therefore eche of them must needes lye in one or other of the azimuthes: and do crosse, or at the least woulde crosse one another vpon the centre of the earth, & in the zenith, if they were bigge inough to fill out a great

circle

circle of the ſpheare, euen as you ſee the lines of this preſent figure, euery of which repreſenteth a perpendiculer wall, the circle A D, B C, is here the horizon, his centre is the Zenith: A B is the meridian or South azimuth, in which circle, the Eaſt and VVeſt wall lyeth, by the 12. and 13. chap. C D is the Eaſt azimuth, called of many authors ſimply, *Circulus verticalis*, the vertical circle, whereof the South diall is called of diuers, *Horologium verticale*: notwithſtanding al the azimuthes are vertical circles, ſo called, *quia tranſeunt per verticem*, I ſay in this Eaſt azimuth C D lieth the South and North wall by the 10. and 11. chap. the line E F repreſenteth a South wall, declining Eaſt, and a North wall declining VVeſt, lying in the 45. and 125. azimuth, for the azimuthes are counted from the Eaſt vnto 360. The line G H repreſenteth a South wall declining VVeſt, and a North wall declining Eaſt, lying in the 135. & 315. azimuth, and ſo of all the reſt, which you ſee in this figure drawn within the leſſer circle, repreſenting the globe of the earth, & are to be extended, or as many other as you can imagine. It is moſte certaine and manifeſt by the 2. def. that the poles Zenith and Nadir of euery azimuth lie in the horizõ, as the poles of euery meridian lie in the Equinoct. VVherfore as the pole Zenith of a ſouth wall, muſt needes lie by the ſayde definitiõ in the ſouth point of the horizõ, euẽ ſo the pole Zenith of any declining wall reſpecting the South, departeth ſo much frõ the South point, as the declinatiõ cõmeth to: & ſo likewiſe of any wal reſpecting the north:



his pole Zenith departeth from the North point, according to the declination, inſomuch if you will aske mee what the declination of a wall is; I ſay it is the diſtance between his pole Zenith, & the ſouth or north points by deg. of the horizon: & looke which way the pole Zenith departeth, thence is the declination denominated or called, as if the pole Zenith of a wall lie betweene the South & Eaſt point, then is that wall called a South wal declining Eaſt: & ſo of the reſt. As for example, in this figure the pole Zenith of the South wall C D is B, but the pole Zenith of the North wall C D, is A. Likewiſe of the Eaſt wall A B is D, & of the VVeſt wal A B, is C, for euery circle hath 2. faces, as is ſaid in the 10. preamble. Alſo of the South wal declining VVeſt E F, the pole Zenith is H, whoſe declination is the ſpace H B, but of the Northwall declining Eaſt, repreſented by E F, the pole Zenith is G, whoſe declination is A G, and ſo of the reſt. By all this you may well gather, that euery wall, flat, and horizon, ought to take his name of the place or point where his pole Zenith lieth, and not of his owne ſcituation: for if I ſhould ſay, make me a diall to the wal C D, who could tell, whether I meant a North or South diall, but if I ſay make me a diall to the South wall C D, it is eaſie to vnderſtand: wherfore me thinketh as I ſhewed in the 5. chap. they abuſe their tearmes who call that an Equinoctial dial, whoſe pole Zenith is the pole it ſelfe, mentioned in the 7. chap. which in my opinion ought to bee called a pole or polare diall. Laſtly, al declining walles are deuided into 2. ſorts, & eche of thoſe againe ſubdiuided into other two: the diuiſion is into North declining, and South declining: of which the firſt haue their pole Zenithes in the North ſemicircle C A D, the 2. in the South ſemicircle C B D, the ſubdiuiſion of the North declining is into North, declining Eaſt: whoſe pole Zenithes lie in the northeaſt quadrãt A G D, & North declining VVeſt, whoſe pole Zenithes lie in the northweſt quadrant A E C. The ſubdiuiſiõ of the South declining, is into ſouth, declining Eaſt, whoſe pole Zeniths are in the Southeaſt quadrant B F D, & into South weſt, whoſe poles are in the quadrant C H B.

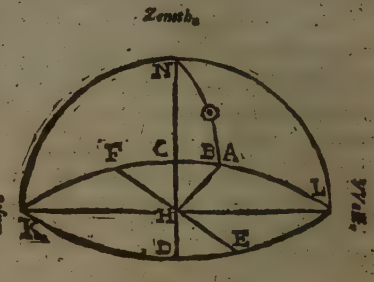
Chapter 15.

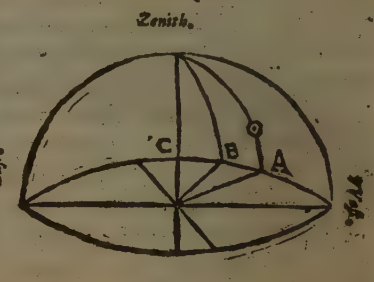
How to know the ſcituation of any wall, and to finde how much he declineth.

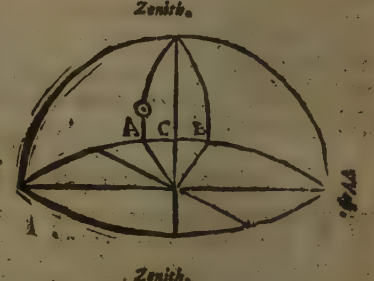
VVHat the declination of walles are with the diuerſities of them, is ſhewed in the laſt chap. In this I wil ſhew how to take the declinations of al walles reſpecting the South: by which any man may do the like for walles, reſpecting the North, the woorking being al one. By a wall reſpecting the South, I mean a South declining wall, & it is eaſily to be known, becauſe the Sun being in the South, yet ſhineth on him though he decline neuer ſo farre Eaſt or VVeſt, by which you may alwaies knowe a South declining wall: wherfore when you come to any ſuch wal: Firſt deuiſe to place your *Iewel* vpon ſome ſtoole or otherwiſe *Leuel* with the horizon: but ſo that the line of *Leuel* may directly ſtand perpendiculer or ſquare from the wall: neither is it material whether he ſtande cloſe to the wal or not: which to do one way is thus: If the wal haue any returning ſquare neere the place, then chooſe your ſtanding, ſo that laying the rule on the ſaid *leuel* line, you may through the ſights looke directly with the end of the wal, as if you would make a dyal on the ſide of a houſe, commonly the ende of the houſe ſhutteth ſquare vpon it, ſo that if you lay the *Leuel* line directly with the end, then he ſtandeth ſquare to the ſide. Another way is thus: get a large ſquire, ſet one ſide euen to the wal, and parallel to the horizon, and hãg at the other ſide 2. plum lines, at eech end one, there let one hold it til you haue choſe you a ſtãding: ſo that the rule lying on the *Leuel*, you may ſee through the ſightes, the one plum line hiding the other. & there fixe your *Iewel* on the ſtoole.

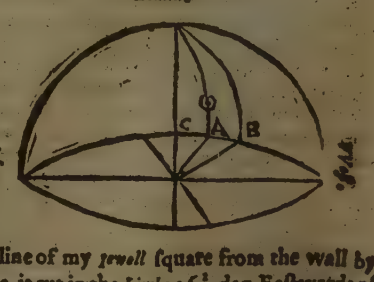
The

The third and beſt way is I think is, eyther to faſten your *Iewel* with waxe or pitch on the ſide of a ſquire ſo that his line of *Leuel* lye euē with it, or els to get a little ſquare boord or block: or for a ſhift, a ſquare trēcher may ſerue, and thereon draw a line through the middeſt, perpendiculer from one of the ſides: in which place the *Leuell* line of your *Iewel*, and apply it to the wall. VVell, to come to the matter, when you haue thus placed your *Iewel*, then doth the *Leuell* line poynt directly to the pole Zenith of the wall: therefore turning about the rule till the ſun pearce both the ſightes, or at the leaſt erecting a wyre in the one ſight, the ſhade thereof beyng proiected on the other: you haue in the *Limb* of your *Iewel*, the horizōtal diſtāce between the Sun, & the wals pole ∠enith (that is to ſay) betweene the aζimuth, wherein the Sunne is then, and the aζimuth cutting the walles pole ∠enith: wherefore you muſt preſently take vp your *Iewel*, and take the altitude of the Sun, by whiche & the 3. booke 6. chap. you ſhall know in what aζimuth reckoned from the South, the Sun is then, either Eaſtwards or VVeſtwardes. Nowe by the Sunnes azimuth known, and his diſtaunce from the pole ∠enith of the wall, you ſhal alwayes know the declination of the wall by theſe rules following: therefore marke thē well, together with theſe 4. figures, in which the circuite C L D K repreſenteth the horizon D C, the meridian C being the South part thereof, N the ζenith, N A the aζimuth wherein the Sun is: E F the baſe of the declining wall, B his pole ∠enith, B H the line in which the line of *Leuel*, muſt lie, K Eaſt, L VVeſt. Firſt, if the Sunne be directly with the *Leuell* line of the *Iewell*, that is to ſaye, hauing no diſtaunce from the pole ζenith of the wall, as in this figure, then is the Sunnes aζimuth reckoned from the South, equall to the walles declination, that way as the Sun lyeth, Eaſt or VVeſt: but as this ſeldom happeneth, or not at all, if you chooſe the beſt times: ſo in all other caſes you haue three thinges to bee noted, that is, whether the wall decline Eaſt, which you may bee ſure of in the morning: for in al wals declining Eaſt, the Sun commeth to them before 6. & departeth at night before 6. In VVeſt declining he commeth after 6. and ſetteth after 6. then muſt you note whether the horizontall diſtaunce of the Sunne from the pole ∠enith of the wall be on the Eaſt or VVeſt part of the *Leuell* line. Laſtly, whether the Sunnes aζimuth found, bee Eaſt or VVeſt from the meridian: al which you muſt be ſure to note downe, which done, then in all Eaſt declining walles, if the diſtaunce of the Sunnes a∠imuth from the *Leuell* line, chance to be Eaſt from the *Leuell* line, as A is from B, and the Sunne alſo Eaſt from the meridian as A is from C, in this 2. fygure, then take the deg. of the diſtaunce, videl. A B out of the degr. of the a∠imuth, videl, A C, the remainder vnto B, C is your deſire, if the diſtaunce be VVeſt, as A is from B, and the Sun VVeſt, as A from C, in this 3. fygure, then take the aζimuth, videl. A C, out of the diſtance videl. A B, ſo reſteth B C your deſire: but if the diſtance be VVeſt, as A is from B, and the Sun Eaſt as A is from C, in this fourth fygure, then adde the diſtaunce videl. A B to the aζimuth, videl. A C, and ſo euery way haue you B C the declination of the wall if hee be a South wall declining Eaſt.









But if the wall decline VVeſtwards, then if the diſtaunce bee VVeſt, and the Sun VVeſt, take the diſtance from the aζimuth, if the diſtance be Eaſt, and the Sun Eaſt, take the azim. out of the diſtance. But if the diſtance be Eaſt, & the Sun VVeſt: adde the diſtaunce to the aζimuth: and ſo haue you the declination of any South wall bearing VVeſt. All which you may perceiue by the laſt 3. figures, ſo that the words Eaſt and VVeſt change places. Theſe rules ſhew harde, but you ſhall little neede them when you are working: for the very ſcituation of the diſtaunce and the Sunne, will almoſt alone direct you. Onely I ſet down theſe, leaſt you ſhoulde doubt in any thing. Beſides that, you may eaſe the matter thus: if the wall decline Eaſt, come betimes in the morning, and the Sunne and diſtance ſhall be both Eaſt: if VVeſt, towards the euening, & they ſhall both be VVeſt: ſo that in both theſe you need but take the diſtaunce out of the azimuth, according to the ſeconde figure: whiche tymes are more conuenient then about the middeſt of the daye to gette the Sunnes exact azimuth by his altitude, as by proofe you ſhall finde.

For example, the 26. of Iulie 1581. the ☉ then beeing $12\frac{1}{2}$. in ♌, I being requeſted to make a diall on the Church wall of Sooning beſides Reading, to ſet the clocke by, did place the *Leuell* line of my *Iewell* ſquare from the wall by helpe of a ſquare boorde: then turning about the rule to the Sunne, it cut in the *Limbe* $36\frac{1}{2}$. deg. Eaſtwards of the *Leuell* line, which I noted in a paper, and quickly tooke vp my *Iewell* and tooke the altitude of the Sun 45. deg. the ſame inſtant, by which & the 3. booke 6. chap. I found the Sun to bee in the 53. azimuth reckoned from the South Eaſtwards: wherfore according to the 2. figure, taking the diſtance $36.\frac{1}{2}$. out of the azimuth 53. there remained $16\frac{1}{2}$. the true declination of the wall. For taking the declinations of North walles the

difference is nothing but that you must reckon the Sunnes azimuth from the North, as here is done from the South.

Another example, the 14. of August 1581. the ☉ being in ♍ $1\frac{2}{3}$. de. I took the declinatiō of another wal about the same church, declining VVest, to serue the after noone: wherefore comming thither towards the euening, I found the distance VVest 20. deg. and the azimuth VVest $73\frac{1}{3}$. degrees, then taking as before the distaunce, vz. 20. out of the azimuth $73\frac{1}{3}$. there rested $53\frac{1}{3}$. deg. the wals true declination VVestwards. Note that if the ruler of your *Iewell* want necessary sights for this purpose, you may hold a threed, and plummet in your hand, so that the shade of the threed cut the centre of the *Iewell*, and then placing the edge of the rule euen with the same shade, you haue your desire.

Chapter 16.

How by the declination of any wall knowne, to finde his eleuation with his angle of deflexion.

THe eleuation of a wal is alwaies the height of the cock, for as I haue often said, the cock of any oblique diall, must be eleuated in his due place, as much as the pole is eleuated aboue the wal wheron it stādeth. The angle of deflexion, I cal the angle made between the 12. a clock or plūb line of the wal, & the line where the cock must stand: which line is also the meridian of the horiz. represented by the wal. VVherefore reckon on the *limbe* of your *Iewel* the walles declination learned by the last chap. and that from the pole rightwards, if the wal declining East, or leftwards, if VVest (though it be not material which way but only for the demonstrations sake following,) and thereto lay the Zenith of your *Reete*, then reckon on the axetree line frō the centre the eleuation of the South wall or the cōplement of the latitude, al is one, & mark what azimuth of your *Reete*, doth cut the axtree line in that deg. for if on the same azimuth you reckon thence to the *Finitor*, you haue the poles eleuation to that wall, and the degrees of the *Finitor* between the same azimuth & the centre is the 4. angle of deflexion.

Example, the declination of the first wall mentioned in the last chap. was there found $16\frac{1}{2}$. degrees Eastwards, which $16\frac{1}{2}$. deg. I reckon on the *limb* of my *Iewel* frō the pole rightwards, thereto I lay the zenith of my *Reete*, which done, I number on the axetree line from the centre, the South walles eleuation, vz. $38\frac{1}{3}$. degrees & there do I see to cut the $12\frac{1}{2}$. azim. reckoned frō the zen. line, on which $12\frac{1}{2}$. azi. cōsinting frō the said $38\frac{1}{3}$. de. to the *fin.* I find $36\frac{1}{3}$. deg. which is the eleuation of the South pole to that declining wall, then on the *finitor* betweene the sayd azimuth, and the centre I find $12\frac{1}{2}$. deg. which is the angle of deflexion of the same wall: & so much must the cock stand from the plumbe line, which in all perpendiculer walles representeth our meridian. This truely is a singuler conclusion which you will confesse, if you conceiue the reason of it, which is thus. The *limb* of the *Iewel* representeth our horizon the axtree line our meridiā or East wall: the Equinoctial the East azimuth or South wall: the end of the Equinoctial line rightwardes, the East point of our horizon, the other end the VVest: the centre the Zenith or rather his Nadir: the *Finitor* the declining wall, and the Zenith of the *Reete*, the pole Zenith of the same wall. All this so determined, and the distaunce of the South pole from our Nadir, vz. $38\frac{1}{3}$. deg. reckoned on the axtree line frō the centre, there must needs bee the south pole. Therefore the $12\frac{1}{2}$. azimuth cutting the same $38\frac{1}{3}$. deg. must needes represent the meridian of the wall by the definition of a meridian which is to cut the poles and passe by the Zenith of his horizon, and because the height of the pole is alwaies the arch of the meridian betweene the pole eleuated and the horizon: therefore the saide $36\frac{1}{3}$. deg. must needs be it. But what may you see more, O notable singularity of an instrumeng that is, inasmuch as you see that the angle made betweene the said $12\frac{1}{2}$ azimuth. and the axetree at their crossing in the said $38\frac{1}{3}$. deg. to be VVestwards on the *Finitor*: therfore you might be sure if I had not tolde you, that the angle of deflexion must be made on your dial VVestwards from the plumbe line, for it is a generall rule, if the diall decline East, then must the cocke stand on the VVest side of the plumbe line, if VVest then on the East side.

Chapter 17.

To perfourme the last chap. a second way by the 6. chap. of spherical triangles.

THough I tooke some more paines then needes in the laste chap. to shewe you some pleasure, I meane to take the more ease in this: for in truth the last chap. is onely performed by the 7. chap. of spherical triangles, inasmuch as the question demanded fel out to be the 2. sides vnknown of a right angled triangle, whose one side $38\frac{1}{3}$ was knowne, and one of the angles not right, which was the complement of the declition, that is to say, the angle betweene the axetree and the *Finitor*: and therefore the last chap. and the sayd 7. chap. of trian. wel vnderstood, it is as easie to doe it by the 6. chap. thus: the declination of the wal giuen, videl. $16\frac{1}{2}$. deg. take that from 90. so haue you the complement thereof, vz. $73\frac{1}{2}$. whiche number from the *Limbe* among the meridians in the same $73\frac{1}{2}$. meridiā found, reckon ꝑ side giuē being the south poles eleuatiō, vz. $38\frac{1}{3}$. deg. and thereto lay the rule, & so are the degr. of the rule betweene the saide $73\frac{1}{2}$. & the *Limbe* the poles eleuation, which you shall find, as in the last chap. $36\frac{1}{3}$. deg. the deg. of the *limbe* between the rule and the pole, vz. $12\frac{1}{2}$. as before are the deg. of the angle of deflexion: now iudge whether my worke of spher. trian. be not profitable, the study of which brought me to al this, and wil bring any man to much more that will consider wel of it.

Chap.

Chapter 18.

To performe the same a third way.

GOod God so infinite is the vse of this *Iewell*, that I should not know how to finish, but that want of time will driue me to hasten one end or other: here haue you now a third way to fynd your angles of eleuation, and deflexion, more apparant without wresting of the spheare then either of the other: I shewed before in the 15. chap. that the *Finitor* beyng sette to the latitude, the Zenith line representeth the South wall, and the azimuthes the declining walles, whose pole Zenithes are all scituate in the *Finitor*: wherefore now to come to the matter, set the *Finitor* to the latitude, and reckon among the azimuthes from the Zenith line towards the pole, the walles declination, and the azimuth there representeth the declining wall: then to finde his eleuation, you must seeke his meridian or some portion thereof, which is alwayes a great circle passing by the pole zenith of this wall, and one or both of the poles of the worlde. As for the poles you see where they are, and where the pole Zenith of this wall is, cannot be farre to seeke: for looke howe much the wall or azimuthe is declined from the Zenith line Southwardes: so muche his pole zenith is departed from the South point of the *Finitor*, towardes the centre. VVherefore if you reckon thence inwards the degrees of the walles declination, there is, no doubt, his pole zenith: which being founde, looke what meridian circle you see to goe from thence streight to the pole, must needes be the meridian of the wall by definition of a meridian, and therefore marke where he cutteth the azimuth of the wal, for his degrees thence reckoned to the pole, is the eleuation no doubt, and the portion of the azimuth betweene this hys meridian, and the Zenith poynte of the *Reete*, is the angle of deflection. This chapter doth depende on the reason of the 24. chapter of spherical tryangles.

For example, in the wal declining VVest $53\frac{1}{3}$. deg. mentioned in the 15. chap. the *Finitor* set to the latitude, reckon the $53\frac{1}{3}$. azimuth from the Zenith line southwards, which azimuth representeth the said wal: thē to fynd the walles pole Zenith, reckon on the *Finitor* $53\frac{1}{3}$. deg. inwards from the South, & there shal you fynd the 60. meridian almost counted from the *Limbe*, thence taking his way to the pole, which must needs be the meridian of the horizon represented by this wall: therefore marke where he cutteth the $53\frac{1}{3}$. azimuth, the distaunce on him thence to the pole, you shal fynd $21\frac{3}{4}$. deg. the walles eleuation, and the space betweene the said crossing and the zenith, counted on the $53\frac{1}{3}$. azimuth, you shal fynd 32. deg. $\frac{1}{3}$. the angle of deflexiō. But see more the forwardnesse of your *Iewell*, which sheweth vnasked the difference of longitude of this country from the countrey where to the wall is horizon: vz. 60. deg. almost the distaunce betweene the meridians, cutting the pole Zeniths of eyther place.

Chapter 19.

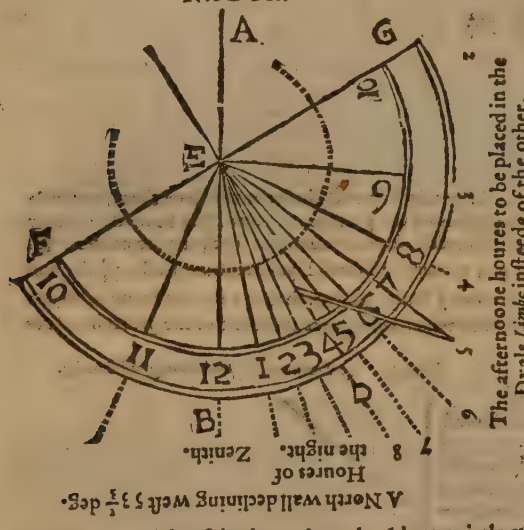
How to make a dial to any declining wall, respecting the South.

THe making of declining dialles before now that this my *Iewel* wil ease it, hath byn very troublesome & paineful with a number of lineaments to be put out after the dial ended, of which the Theorical demōstration was not shewed, as in *Munster* & *Orontius de horologijs*, you may see, whereby you had verye fewe but went blindly to woorke on them. I haue seene instructions in many bookes, how to make the horizon & South wall dialles, as namely in *Albertus Durerus*, *Daniel Sambecke*, *Gemma Frisius*, *Curteise*, and diuers other: but whē t hath come to the declining dials, they haue giuen it ouer in the plaine field.

But to the matter, you may note thus much of your selfe, that euery declining wal is an oblique horiz. because you are driuen to seek his eleuation, wherby you wold think that the dial should differ nothing in making from the oblique diall in the 9. cha. as in effect it doth not, after you haue placed the said angles, & found where you must begin to reckon your houres. VVherfore in Gods name, first make a plumb line on the wal, wherein appoint the centre of your diall: theron making a blind circle equal to your *Iewels Limbe*, as in the oblique diall you made a quadrant: in this blynd circle set the deg. of deflexion, (take from your *Iewels Limbe*) as you are wont, and that below the centre VVestwards of the plumbe line, if the wall decline East: or Eastwardes, if VVest: thereto from the centre draw a long line where the cock shal stand, & crosse the same lyne on the centre with another, sufficiēt for the diameter of your dial: vpō which diameter, make the circle or *limbe* of your dial, in which write 12. at the plumb line, for that is alwaies the 12. a clock line: but now to proceede further, for the deg. of the other houre lines, set the *Finitor* so many deg. vnder one of the poles (the matter is not great which) as the wals eleuation cōmeth to: and so doth the *Finitor* represent the wall, & the *Limbe* the meridiā, to the wal or to that countrey whose horiz. it is. So that if you were in that countrey, you might proceed to make this dial as in the 9. chap. But now to place the houre lines in him to serue our coūtrey, you must seek out on your *Iewel* or meridian: for the *limbe* is here the walles meridian, and from our meridian of necesity we must haue al the houres reckoned: which to find nūber on the *finitor* placed to ♑ eleuatiō as before, the angle of deflexion from the *limbe* inwards, marke what meridian cutteth the *finitor*, there the same is the meridian of our coūtrey, which when you haue, marke him wel that you may know him: for it is he that leadeth this daunce, & is already represented on the wall by the plumb line. VVherefore if beginning from this meridian, you distinguish on your *Iewel* euery 15. going thence: order from 15. meridian to 15. quite roūd, returning at the *limbe* til your compasse be vp: these meridians or rather houre circles thus distinguished, shall cut the deg. on the *finitor* so standing to the walles eleuation answearable to euerye houre in all respectes, as in the oblique dial in the 9. chap. which deg. by help of the blind circle made before, you may place in your dial, remembring that you must here begin from our new found meridian, & not frō the *Limbe* as there: & the spaces, deg. or houres from this meridiā towards the *limbe* of your new *iewel*, must be set in your diall towards the line where there the cock shal stand and so round: the reason is for that the *limbe* is now the meridiā of the wal, & on the dial is the line of the cock, wherby you may see that the cock will not stand out of the meridian of his horizon.

For

For example I will take in hand to make a Dyall to the wall, mentioned in the 15. Chapt. declining VVeſt $53\frac{1}{3}$ deg. therefore the cocke muſt ſtande on the eaſt ſide of the plumbeline by the ende of the 16. Chapt. Firſt I draw a perpendiculer on this wall vz. A B by helpe of a plumbe rule, therein I pitch the centre of my Dyall vz. E, whereon I make a blinde circle equall to the graduated circle on my *Iewels Limbe*, as in the 9. Chapt. whenſe I take in my compaſſe the quantitie or degrees of the angle of deflexion founde by the 16. 17. or 18. Chapt. vz. $32\frac{1}{3}$ and ſet the ſame in the blinde circle Eaſt from the plumbeline at C, becauſe the wall decli-neth VVeſt by which and the centre E. I draw the line E C D, and croſſe the ſame ſquare on the centre with the line F E G, which ſhall be the dyametre of my Dyall, to which on the centre E, I draw two ſemicircles of more, to ſerue for the *Limbe* of my Dyall as you ſee, wherein at the plumbline, I write 12. This prepared, I ſet the *Finitor* of my *Iewel* to the wals eleuation, founde in the laſt Chapter $21\frac{3}{4}$ deg. whereon I reckon in-wards the angle of deflexion $32\frac{1}{3}$ deg. and there do I ſee to croſſe the *Finitor*, the 60. meridian almoſt coun-ted from the *Limbe*, which is now become our meridian, and is he that we muſt truſt to, for he is alreadie re-preſented on the wal by the plumbeline. Now becauſe this 60. meridian is an houre circle alredie marked and diſtinguiſhed on the *Iewel*, I neede not diſtinguiſh him a newe, nor any of the reſt, for that if I reckon from 15. to 15. from him they all fall out in the ordinarie houre circles, which for the moſt part will not ſo fall out though it chaunced ſo here: But now being as it is, marke what degrees of the *Finitor*, the next fifteene houre circle from this 60. meridian towards the *Limbe* doth cutte: you ſhal finde $12\frac{1}{3}$ degrees, which place in your blinde circle from the plumbeline towards the cocke, like as in the oblique Dyal, thereby draw an houreline from the centre of your Dyall, the ſeconde houre circle towards the *Limbe*, cutteth in the *Finitor* $20\frac{1}{3}$ deg. counted ſtill from the in-terſection of our newe found 60. meridian, the thirde towards the *Limbe* cutteth 27. deg. on the *Finitor*, theſe two notes ſet alſo in the blinde cir-cle, and by them drawe two houre lines more: well, the fourth houre circle is the *Limbe* it ſelfe cutting on the *Finitor* $32\frac{1}{3}$ deg. being the angle of deflexion which is alreadie placed in your Dyall where the cocke muſt ſtande. But nowe for the fift houre you muſt returne backe a-gaine on the *Finitor* from the *Limbe* where you ſhall finde the 5. houre circle to cut in the *Finitor* 38. degrees counted from the ſaide 60. meridian to the *Limbe*, and thenſe backe againe: the 6. houre circle cutting $44\frac{1}{3}$ deg. the 7. $52\frac{1}{3}$ degrees, the 8. 66. deg. all which placed in the Dyall as before, you neede go no further that way, for that the ſunne at the moſt in our country yealdeth but 8. houres before or after 12. Now for the hourelines on the otherſide of the plumb-line, begin againe from the ſaid 60. meridian, but the contrarie way towards the centre. and you ſhall finde the firſt houre circle to cutte 24. degrees: the ſeconde $57\frac{2}{3}$ deg. which, place in your Dyall, and you haue done: For beyonde the dyametre you neede neuer go in a perpendiculer wall. Laſtly the hourelines thus drawne, their numbers a childe almoſt may ſet in by the 12. of clocke, or by this figure. And as for the cocke let him be erected verie plumbe from the wall in the line of deflexion drawne for him: his length may be equall to the Dyals ſemidiametre, or ſhorter if you will, but his height muſt needes be to the walles eleuation vz. $31\frac{3}{4}$ and thus haue you a ſinguler peice of skill, which being wel vnderſtoode is more eaſie then to do it Geometricallie after Orontius or Munſter, but ere I finiſh my *Iewel* I will teach to do it Geometrically more eaſie then theirs by farre, hauing but a modicum of my *Iewels* helpe.



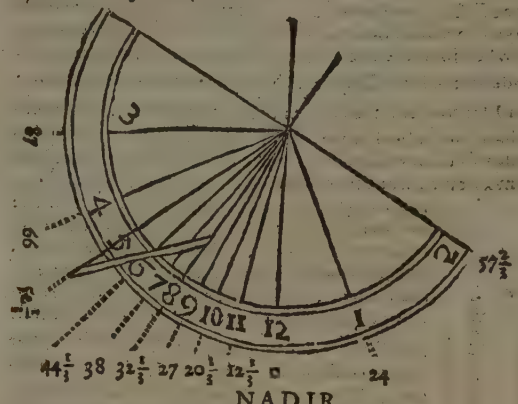
Chaptet 20.

How to make a Dyall to any declining Wall reſpecting the North.

THere is no diuerſitie of making a North declining Dyall, from the South declining, mentioned in the laſt Chapter, but that where as there you did drawe the circumference downewards vnder the centre towards the South pole: heere you muſt make him vpwards towards the Zenith, reſpecting the North pole, and then following on the rule in all reſpectes as in the laſt Chapt. Namely if the wall decline Eaſt, ſet the cocke on the VVeſt ſide of the plumbeline and ſo contrariwiſe: But now is the plumbline 12. of clocke at midnight, whereby you may number the reſt of the houres, the cocke alſo muſt be ſet vpwards, according as I tolde you in the 11. Chapt. and the ſuperfluous houres of the night left out. There is ſo little diuerſitie in the making, that looke what Dyall you make to a ſouth wal declining weſt the very ſame Dyall will ſerue to a North wall declining weſt, like much, if you turne him vpſidedowne and alter the numbers: and ſo like wiſe the South declining Eaſt, ſerueth the northeaſt as by this figure you may plainely ſee, being but the Dyal of the laſt Chapter, turned topſitoruie and the numbers of the houres altered vnto thoſe which I haue placed

at the endes of the prickt lines as you see, and nowe serueth to a North wall declining VVest 53 $\frac{1}{3}$ degrees, whereto the sun commeth not before 2. of clock afternoone, and there continuing til eight of clocke at night, all the rest of the houres be superfluous.

A South wall declining East 53 $\frac{1}{3}$ deg. Zenith. A North wall declining East 53 $\frac{1}{3}$ deg.



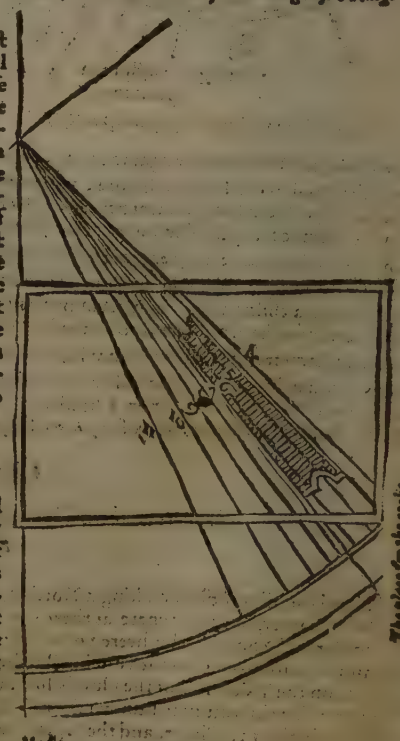
NADIR.

And heere if I should conceale one thing, I should offer you iniurie and hinder my selfe of that I pretende which is breuitie and facillitie: I will therefore that you know if the patterne of your Dyal be made in paper first, as I commonly vsed, and that the paper were oyled or prickt so that you might see the figure of this Dyal on the backside, the same doth represent the cocke turned vpwards, a North Dyal declining East 53 $\frac{1}{3}$ degrees & the cocke turned downwards a south wall Dyal declining East 53 $\frac{1}{3}$ deg. so that you may by one paterne make 4. seuerall Dyals as by these figures you may see, vnto which the figures at the end of the prickt lines expresse the houres.

Chapter 21.

How to order Dyals that decline very farre East and west.

Zenith. *A South wal Dyal declining west 80. deg.*



I Shewed you before in the 12. Cap. that euery east & West wall is a right horizon, hauing the hourelines of the Dyall parallel, & the pole nothing eleuated to that wall, because he standeth in the meridian & cutteth the pole: wherefore it must needs appeare that the more any wal declineth towards the East or VVest, the lesse the pole is eleuated, euen vnto nothing at the last, whereby the hourelines neere the cock or meridian of the wall, grow so neere togither that towards the centre they thrust one vpon another, & farther off they shew almost parallel: for in a wal declining 80. deg. east or west, some of the houre spaces are not aboue 2. deg. or little more, which space except the dial be monstrous big, cannot be sufficiently discerned, wherefore you may cut of the dyal, cock and all, with a fashionable square like an east Dyal, as you see done in this figure, which the sheweth almost like vnto it, you may make him first in paper, & then hauing cut off all superfluitie, set the 12. of clock line euen with the plumbline, and so by the paper prick the other houres.

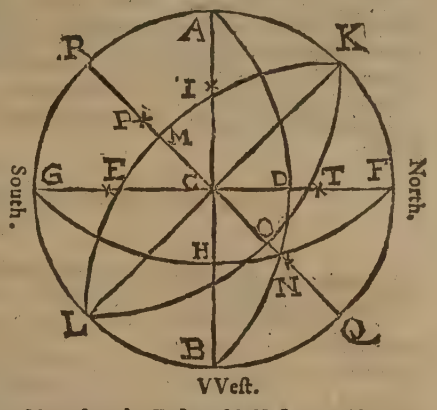
Chapter 22.

Of wals reclining and inclining, and of the diuersitie of them.

I Shewed in the 14. Cap. the diuersities of declining wals and that euery perpendiculer wal declining or not declining lay in one or other of the azim. their pole zenithes being all of them in the horizon or *Finitor*. In like manner reclining wals are flats, whose bases lie leuell with the diametres of one or other of the azim. crossing all vpon the centre of the earth, but their flats recline or beare backe from the zenith, & their pole zenithes are eleuated aboue the horizon in the azim. standing square to their base as much as the reclination commeth to. The inclining wall or flat, for his base he is like the reclining, lying in the diametre of one of the azim. but his face or flatte is inclined forwards, lying groueling from the zenith: in so much that his pole zenith is sunck so much vnder the hor. as the inclination commeth to, which by this figure you may conceiue, wherin the circle A I B G is the horiz. the centre C the zenith, the streight lines crossing at the

centre

centre repreſent both azimuthes and their diametres, the arch A D B is a reclining wall, whoſe baſe is the line A B, being the dyametre of the azimuth A C B, this wall A D B reclineth from the zenith as manie degrees as C D containeth, wherefore his pole zenith ſhalbe eleuated in the azimuth ſquare to his baſe vz. F C G, as much as C D commeth to, and is the point E, ſo that G E is equall to C D. Likewiſe the arch A D B repreſenteth an inclining wall, whoſe baſe is A B alſo, bending forwards towards the point F from the zenith C, according to the quantitie of C D, whoſe pole zenith is the point T, which you muſt imagine depreſſed or ſunke vnder the horizon A F B, in the ſame azimuth F C G, as much as D inclineth from C, or as the point E is eleuated aboue the horizon, and ſo of all the reſt in this figure. And thus vpon the diametre of any azimuth whatſoeuer, there may be imagined both a reclining and inclining wall, nay rather a number of both kindes according to the reclination of the point D from the centre C. Then to proceed further, know that as the diuerſitie of perpendiculer wals are eaſt, weſt, north, ſouth, and declining, ſo is there the like of theſe, for either the baſe of reclining, or inclining walles lie in the dyametre of the Eaſt azimuth, as A B, and then are they called North or South, reclining or inclining, or in the diametre of the meridian or ſouth azimuth, as F G, and then are they Eaſt or VVeſt, reclining or inclining, or elſe in the diametre of ſome other of the azimuthes, as K L, or Q R, or any other, and then are they called reclining walles declining and inclining wals declining: which you may deuide and ſubdeuide, I meane their denomination as in the perpendiculer wals in the 14. Chapt. as thus, K O L is a ſouth reclining wall, declining Eaſt, becauſe his pole zenith is the point P, his reclination is the ſpace C O, his declination R G, alſo K L O is a north inclining wall, declining weſt, whoſe pole zenith is the point N vnder the horizon, & thus you may ſpell them all, and as many other as you liſt to imagine, *eu ipſe annitere potis.*

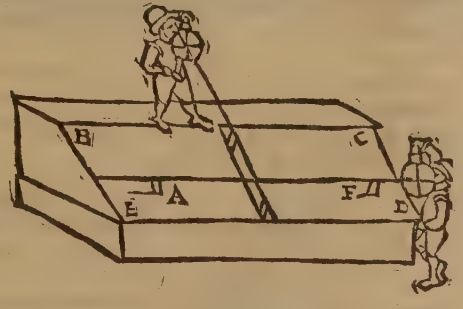


Note that the Eaſt and VVeſt are miſtaken in making this figure.

Chapter 23.

How to take the reclination, or inclination of any wall or flat, togither with his declination if any be.

VVHen you come to any reclining flatte, firſt by helpe of a Maſons leuell or ſome other deuiſe, draw thereon a line parallel to the horizon, which by helpe of your *Iewel* you may alſo thus do, ſticke a long ſtile or wyer vz. A plumb for the flat B C D E, and then ſetting your *Iewel* to your eye, the rule with ſights lying on the line of leuell, go euen with the ſide of the flat through the ſight, beholding the ſtile, and let ſome other bodie ſticke vp another ſtile vz. F, directly betweene your eye and the firſt ſtile, plume alſo from the flat: then drawing a line by both theſe ſtiles vz. A F, the ſame ſhalbe leuell with the horizon: this horizontall line I will call the baſe line of the reclining flat, to which I drawe another croſsing him ſquare, which I will call the baſes perpendiculer, both which drawne, I then applie my *Iewel* by helpe of the ſquare boorde or ſquire, mentioned in the 15. Chapt. vnto this baſe line leuell with him horizontalwiſe, and ſo by the doctrine of the 15. Chapt. take the declination of this reclining flat in his baſe line, euen as though it were a perpendiculer wall: which I note downe in a paper or tables, but if this baſe line haue no declination, that is to ſay, be full Eaſt, VVeſt, North, or South, then is the ſame flat barely reclining, and not reclining declining, which reclination to take do thus: erect two ſhort ſtiles in the baſes perpendiculer, both of equal height aboue the flat and plumbe thereto: then if the flat be a ſlope wall, as of a buttreſſe or ſuch like, hang your *Iewel* to your eye, remoouing your rule with ſightes till you may through them ſee the very tops of the two ſtiles, and ſo are the deg. of your *Iewels Limbe* counted from the line of leuell, the mounting of this flatte aboue the horizon, the complement wherof being the deg. betweene the rule and the zenith, or handle of the *Iewel* is the flats reclination, but if it chaunce to be the bancke of a garden, or any other that you may go aboue it, then is your beſt way to place your ſelfe aboue the ſame, and to looke downewards through your ſights by the ends of the two ſtiles.



For example Anno Dom. 1581. A Gentleman of auncient houſe and great worſhippe, Humphrie Foſter Eſquire by name, being elected heigh ſhiriffe of the countie of Berkes, beſtowed the ſame yeare ſome coſt about his houſe at Aldermarſton, where amongeſt other thinges, hee trimmed vp two Gardens with walkes vppon heigh ſlope banckes as the order is: and for becauſe one of the banckes lay verie open to the ſunne, and to the proſpect of moſt of the Chambers and roomes of the houſe, it pleaſed him to vſe my ſimple helpe, being his verie neere kinſeman, and ſuch a one as not without greate cauſe hee might commaunde, to make a greate Dyall at the whole bredth of the bancke being almoſt three yeardes deepe: wherefore I laide aſtreight boorde on the toppe of the bancke directly with the edge thereof, which

ſerued me for my baſe line, becauſe the banck was leueled, of which I tooke the declination by the 15. Chap. and founde it 78½ degrees, then did I by the firſt concluſion direct a perpendiculer from this baſe line, vnto the foote of the bancke, wherein inſteede of ſtiles I ſtucke two kniues of equall height aboue the banck: and then chooſing my ſtanding on the heade of the bancke, ſo that I might through the ſights of my *Iewel* ſee the verie toppes of both knyues, I found the end of the rule next my eye to cut on the *Limbe* 34. deg. which counted from the line of leuel which was the mounting of this bancke aboue the horizon, the complement whereof vz. 56. degrees, was his reclination from the zenith, being the degrees betweene the rule and the handle, or toppe of the *Iewel*, ſo that I was to conclude that this bancke was a South reclining flatte 56. deg. declining Weſt 78½ deg. whereto I will ſhew to make the Dyall in the 28. Chapt. But now for to take the declination and inclination of any flatte, the working is all one, as by experience you ſhall better finde then by manie words.

Chap. 24.

How to make a Dyall to a ſouth or north reclining or inclining wall, bancke or flatte.

A South or North reclining or inclining flatte is ſuch a one by the 21. Chapt. whoſe baſe lieth in the Eaſt line of the horizon, and his pole zenith in the meridian circle, which well vnderſtoode, and the reclination taken and knowne by the laſt Chapt. the making of the Dyall thereto is moſt eaſie. Firſt ſet the *Finitor* of your *Iewel* to the latitude: then if the flatte recline or incline Northwards from the ζenith, remoue the zenith line of your *Reete* ſo many degrees towards the North pole, as the reclination commeth to, or towards the ſouth pole, if ſouthwards: and you ſhall thereon ſee preſently which pole, and howe many degrees the ſame is eleuated aboue your flatte, to which eleuation make your Dyall, either by the 9. or 10. Chapt. placing the cocke and 12. a clocke in the baſes perpendiculer ſouthwards, if on your *Iewel* you finde the ſouth pole eleuated: or northwards, if the north pole.

As for example, admit that in our latitude being 51⅔ deg. by the 23. Chapt. I founde a ſouth flatte reclining 20. deg. Firſt I ſet the *Finitor* to our latitude by the 2. booke 19. Chapt. there I finde the zenith point of the *Reete* to ſhew 38⅓ deg. counted from the north pole. Thence I remoue him according to the reclination found vz. 20. deg. more from the ſouthwards, where I finde the North pole diſtant, or rather depreſſed 18⅓ de. vnder this flat, being the zenith line: but looking towards the other end therof, there I finde the ſouth pole 18⅓ degrees eleuated aboue this flat by the 10. preamble. For this is generall that the zenith line, I meane drawne forth vnto his Nadir, ſupplieth al flats, whoſe poles zenith & poles Nadir lye in your meridian circle. VVherefore now by the 9. or 10. Chapt. making an oblique Dyall to 18⅓ eleuation, his cocke and 12. of clocke ſtanding in the baſes perpendiculer turned towards the ſouth, you haue done. And the ſame Dyall the 12. and cocke turned north, ſerueth the north flat in our latitude inclining 20. deg. But if a South wall be reclining, or a North wall inclining according to the Equinoctials height aboue our horizon vz. 38⅓ degrees. then will the zenith line one your *Iewel* lie in the two poles, ſo that neither is eleuated. Wherefore by the 8. Chapt. you may know the ſame flat to be a right horizon, in which Chap. the Dyall is alredie made thereto. If a South wall recline or a North wall incline more then the Equinoctials height in your latitude: as admit with vs 60. deg. your *Iewel* firſt placed to the latitude, remoue the ζenith line towards the north pole and beyond, till he come to 60. deg. from his right place, and you ſhall there finde the north pole diſtant, and eleuated aboue the ſaid ſouth reclining flat 21⅔ deg. and the ſouth pole eleuated or rather depreſſed vnder the ſaid North reclining flat as much vz. 21⅔ deg. for the zenith line repreſenteth them both: to which eleuation you may make their Dyals by the 9. & 10. Chap. as is aboue ſaid. In the very like manner is it with north reclining and ſouth inclining flats *vice verſa*.

Chapter 25.

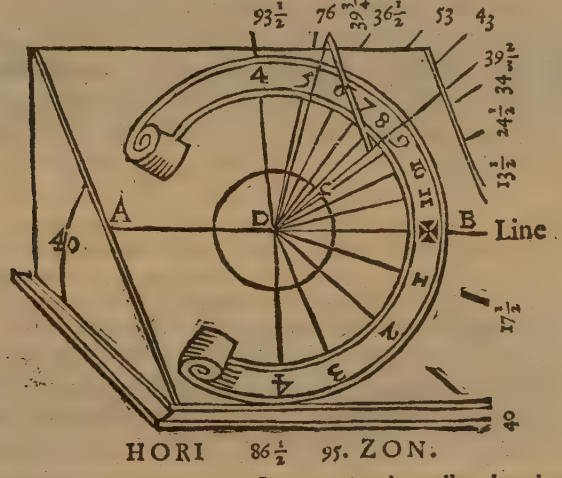
How to make a Dyall to an Eaſt and Weſt wall, bancke or flat reclining or inclining.

THe baſe line of euery Eaſt and Weſt reclining and inclining flat lieth directly in the meridian line, as in the 21. Chapt. and in truth euery of themſelues lyeth in the flat of one or other of the circles of poſition: (that is to ſay) they all croſſe vpon the interſection of the meridian with the Horizon, as the declining wals do in the zenith and Nadir, their poles zenith and Nadir lying all in the circle of the Eaſt, called of ſome the verticall circle. What a circle of poſition is, looke the 3. Booke 43. Chapt. The Dyall to euerie of theſe is made in all reſpects as the declining wall dyall. And to make the matter more plaine to the learner, whom I would as willingly helpe as I onſe could haue beene contented to be holpen, know that all reclining and inclining Dyals of this ſort are the very declining wal Dyals to that country which hath a ſouth latitude equall to the complement of your latitude being heere at Reading 38⅓ degrees. Wherefore if you did but imagine your ſelfe in a South latitude, of 38⅓ deg. & turne your *Iewel* vpſidedown accordingly as you do here in your owne, you may eaſily perceiue the zenith line to be there your verticall circle, and all the Azimuthes your declining wals, which are heere circles of poſition, and may make your Dyals to them by the 19. Chapter. Nowe notwithſtanding I thinke it plaine ynough to ſome alredie, yet I will not ſticke for other ſome to proſecute this Chapter demonſtratiuely, the rather becauſe I haue ſet but one example of declining VVall Dyalles. Admitte therefore heere in our latitude being 51⅔ at Reading: by the 23. Chapter, I founde an Eaſt VVall reclining from our zenith 50. degrees, I call that an Eaſt reclining

wall

wall or flat, whose pole Zenith is in the East quadrant of the verticall circle To make a diall to this flat, you shall in steede of the *finitor*, set the Zenith line to the latitude, vz. $51\frac{2}{3}$. degree, vnder the North pole, so shall the azimuthes represent all the East and VVest, reclining or inclining flats, and the *finitor* line now supplieth the Zenith line for this turne. Then since my wall proposed, reclineth 50. degrees from the zenith, I reckon so many degrees on the *finitor* from the *Limbe* inwardes, and there doe I finde the 50. Azimuth representing my flat sought for: aboue which also I may see the North pole eleuated: but howe much, since it appeareth not, you may thus finde. Marke which of the almicantares cutteth the pole, and where he crosseth this 50. azimuth: if thereto you set the *label* fixed: the degrees thereof betweene this crosing and the *limbe*, you shall finde $36\frac{1}{4}$. which is the poles eleuation aboue that flat, and the degrees of the *limbe* betweene the *label*, and the pole, $39\frac{2}{3}$. the angle of deflection. Thus may you finde the eleuation and deflexion of any of the azimuths either in this constitution or any other like, as declining walles, &c. For it is but the rule of the 17. chapter, somewhat more plainely set downe for this purpose. These had, you shall draw through the middest of your reclining flat, his base line parallel to the horizon, vz. A B, which, as is said, in all these dialles, lyeth directly North and South, euen in the meridian line. In this base line A B, pitch the center of your diall, vz. D, and thereon describe a *Limbe* for your diall to write the numbers in, and within it a blind circle equall to your *Iewels limbe*, wherein set the note C, $39\frac{2}{3}$. de. (being the angle of deflectiō) aboue the base line Northwards: because the North pole is eleuated, drawing foorth the line D C, where your cocke must stande in all respects, as in the 19. chap. you did in the declining wall, from which this little had differed, if in steed of the reclination, I had taken this complement being 40. degrees, vz. the mounting of this flat aboue the horizon: and reckoned this 40. from the Zenith line, where here I counted 50. from the *limbe*, all commeth too bee one azi-

An East flat reclining 50. deg.



muth. But to proceede, now you must remoue the *finitor* of your *Iewel* to the walles eleuation founde) that is to say) set him $39\frac{3}{4}$. deg. vnder the pole, wheron from the *limbe* inwards, reckon the angle of deflection, vz. $39\frac{2}{3}$. deg. which angle alwayes hunteth out our meridian, for there shal you see to cut the *finitor*, the 54. meridian counted from the *limbe*, which is he frō whence we count all our houres: being in this figure, the line A B, the *limbe* of the *Iewell* is as hath been saide in the 19. chapter, the meridian of the flatte, and representeth the line D C, where the cock stādeth. In this figure frō the crosing of this 54. merid. with the *finitor*, reckō to the next 15. meridian towardes the *limbe*, which you shall see to cut in the *finitor* $13\frac{1}{3}$. deg. frō the crosing: those deg. I set in the blinde circle from the base line A B, towardes D C, the line of deflection, and thereby draw a line thorow the same to the dials *limbe* for my first houre on that side: then look I on my *Iewell* to the next 15. meridian, being 30. meridians from the said crosing he cutteth on the *finitor* $24\frac{1}{2}$. deg. counted from the crosing for the second houre line. Then the next 15. meridian beyonde that, he cutteth 34. deg. of the *finitor* for the third houre line: these two houres I set likewise in my diall: then haue I but 9. meridianes more to the *limbe*, therfore I must reckon thence backe againe tyll 15. be vp, which are 6. deg. backe, reckoning on the *finitor* from the said crosing to the *limbe*, and thence backe againe to the same 6. meridian I finde so 43. de. for the fourth houre: which being set in my diall, falleth out beyond the line of deflection, so that heere the cocke standeth betweene two houres lines. And so proceeding for the rest, as in the declining diall: you shall finde 53. deg. for the 5. houre line, $63\frac{1}{2}$. for the 6. 76. for the 7. $93\frac{1}{2}$. for the 8. and so foorth if neede were. But in our countrey 8. houres from the 12. any way is enough at the most. In like maner for the houres vnder the base line, count on the *finitor* from the said crosing towardes the center of the *Iewel*, and you shall find $17\frac{1}{2}$. deg. for the first, 40. for the second, 65. for the third, $86\frac{1}{2}$. for the 4. and so foorth if neede bee. All these seuerall notes made in the blind circle, and houre lines by them drawen to the *limbe* of your diall, and your cocke set Northwardes plumbe from the flat in the line of deflection C D, equall in height to the walles eleuation, vz, $36\frac{2}{4}$. deg. hygh, your dyall is made. The base line A B, beeing that it lyeth in the meridian, must needes be 12. of clock. The rest of the numbers you may by reason set to the other houres. All which by the

figure

figure before you may moſt plainely ſee.

Then for Eaſt and VEeſt inclining flats, the dials are made in very like maner, ſauing that the line of deflection lieth Southwardes, & vnder the baſe line the cocke beholding the South pole, ſo that this diall would ſerue to a VVeſt inclining flat, 50. deg. being turned vpſide downe, & the numbers altered: of all which my minde giueth me that my *Iewel* ſheweth the reaſon ſo theorically that I neede ſpend no more ſpeech thereof.

Chapter 26.

How to finde the angles of the poles eleuation, dials deflection, and meridians aſcenſion, to any reclining or inclining wall declining.

BY the title of this chap. you may ſee that there belongeth to the making of a reclining diall many angles which muſt firſt ſphearically be gotten before the diall can bee made: namely his reclinatiõ frõ the Zenith, his declination from the North or South in his baſe line, his deflection from your meridian, and nowe laſtly another angle lept in, which is the aſcenſion of your meridian aboue the baſe line, which in the laſt diall were both in one ſelfe ſame line: therefore what did I ſay in the 19. chap. that the declining dialles were harde to make before time? It is not ſo perhaps, if that be true, then were inclining and reclining dials more harde, nay moſt hard, yea and ſo intricate, that I haue not ſeene any to haue perfourmed them, but only Andreas Sconerus, yet hee without any theoricall demonſtration. But it is ſuch an intricate peece of work and the worſe by miſprinting that he himſelfe had neede come againe to vnderſtand it. There muſt be ſuch a ſort of circles, lineaments, ſuch a number of quadrants and deuiſes drawen and diuided vpon the wall or paper in ſuche abundance ere the diall can beee made that a man would thinke it a wilderneſſe of lines rather then any reguler peece of worke. Tell me then, if the diamond be ſet by, in that he is rare and ſhineth in the darkeſt places, and cutteth deepe where nothing els wyll ſcratche, who dare cauill that I call my inſtrument a *Iewell*, that ſheweth the moſt hidden & difficult matters of the ſpeare as broad as day, and performeth the hardeſt with plaineſſe & eaſe. But now to come to this defuſe matter which hath balked a great many who haue been very buſie to ſhew their skill in other ſlighter dials.

VVhen you haue the reclination of a wall, flat, or banke, together with the declination of his baſe line, as in the 33. chap. is ſhewed: Firſt place the *finitor* in the axtree line of your *Iewel*, which here ſhall be your meridian, thence remoue the *finitor* frõ the South pole towards the left hãd, if it be of a South flat reclining, & his declination VVeſt or rightwards, if Eaſt according to the deg. of declination, and ſo ſhall your *Iewell* remayne in an excellent conſtitution for this purpoſe As in example of the banck mentioned in the 23. chap. the declination of his baſe line was $78\frac{1}{2}$. from the South VVeſtwards, the reclination 56. deg. VVherefore the *finitor*, firſt laid in the axtree, which heere I meane ſhall repreſent our meridian: remoue the South end thereof leftwards $78\frac{1}{2}$. deg. which done, you ſhall finde the Zenith point of the *Reete*, ſtanding $11\frac{1}{2}$. degr. from the North pole. Now vnderſtand what your *Iewell* doth here repreſent. Firſt the *limbe* is our horizon, the axtree line is the Eaſt wall or meridian in whiche the North pole muſt needes be found, the Equinoctiall is the South wall or Eaſt azimuth, the center is here the Zenith of our horizon, the right hand at this worde *meridies* is Eaſt, and the left hand at *media nox* VVeſt, in reſpect the *Iewell* is heere imagined to lie flatte, the Zenith line repreſenteth the ſide or baſe line of the banck, the *finitor* the baſes perpendiculer, wherein the reclination is taken. Laſtly, if on the *finitor* from the center you reckon the reclination of the banck, vz. 56. deg. there haue you the azimuth repreſenting the bancke or rather the horizon, wherein the flat of the banck lyeth, whereto our dyal muſt be made. Now ſir that you ſee the ſtanding of all the circles of the ſpheare needfull for thys purpoſe in theyr due conſtitutiõ, it is ſome cunning yet to get thoſe angles, which this chap. propoſeth, notwithſtanding one of them is there at hande: for if you reckon from the Zenith poynt of the *reete*, the deg. of the ſaid 56. azimuth vnto his croſsing with the axtree line, you ſhal finde them $13\frac{2}{3}$. deg. which is the angle of our meridians aſcenſion, that is to ſay, our meridian croſſeth the baſe line of this bancke making an angle about it of $13\frac{2}{3}$. deg. for the other angles, firſt reckon in the axtree line, which now is our meridian as in the 16. chap. you did the poles eleuation, vz. $51\frac{2}{3}$. deg. from the *limbe* beeing nowe the horizon, there make a prick with inke for the pole: for now if you can deuiſe with all your skil where ♄ pole Zenith of the bank lyeth on your *Iewel*, and from him to lett downe an arch of a great circle, cutting th ſaide pole or pricke of inke in the axtree line, hee muſt needes repreſent the meridian of the banckes horizon, by the 1. book and 4. chap. and ſtande perdendiculer thereon, wherefore his portion or arch betweene the 56, azimuth, and the ſayd pole or pricke muſt needes bee the poles eleuation & the deg. of the 56. azimuth betweene it and the axtree ſhalbe the angle of deflexion. Now to make this matter plaine by demonſtration, reaſon thus. The Zenith line repreſenteth a wall declining VVeſt $78\frac{1}{2}$. deg, that is to ſay, a wal perpendiculer on the baſe line of this bancke, therefore his poles Zenith & Nadir muſt needes bee in the endes of the *finitor*: but ſince this bancke reclineth from the Zenith beyng the center of the *Iewel* 56. deg. rightwardes: therefore his pole Zenith doth come in as much on the other ſide from the *limbe* towardes the center in the *finitor* line, as in the 4. booke and 4. chapter, and 5. booke and 24. chap. hath been ſaide. This 56. deg. on the other ſide of the *finitor* founde, you ſhall nowe for neceſsties ſake lay the *label* on the axtree line, and therein make the foreſaid prick for the pole, and there the *label* fixed to the *reete*, you ſhall turne about the *reete* and *label* ſo fixed tyll you find ſome of the meridians of the *mater* too cut both the ſaide pole zenith founde in the *finitor*, and the ſaide pole pricke in the *label*, which you ſhall finde to bee done by the $65\frac{1}{2}$. meridian counted from the *limbe* there ſtay your *reet*, and reckon on the ſame $65\frac{1}{2}$. meridian the degrees betweene the ſaide pricke in the *label*, and the ſaide 56. azimuth which you ſhall finde $35\frac{1}{2}$. deg. the ſame is the eleuation of the pole to this bancke. Then reckoning on the 56. azimuth from his croſsing with this $65\frac{1}{2}$. meridian vnto the fiduciall line of the *label*, which nowe repreſenteth our meridian, you ſhall finde 28. deg. the angle of deflexion, and ſo much muſt the

cocke

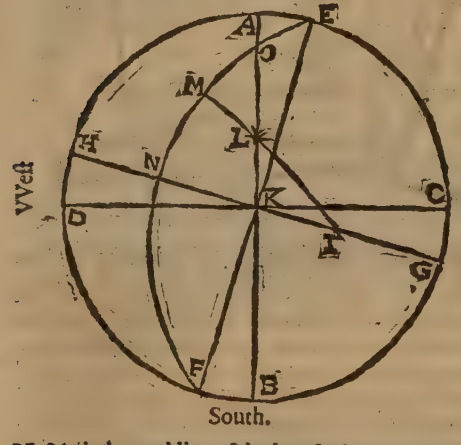
cocke ſtande aboue the meridian: and thus haue you gotten all thoſe angles, beholde the figure of the next chapter, which if you marke well doth after a ſort repreſent your *Iewell*, in the conſtitution of this chapter.

Chapter 27.

How to perfourme the laſt chapter by ſphearicall triangles very eaſily, and with great pleaſure and profite.

SOme perhaps will ſcant giue credite to the finding of the angles in the laſt chapter, perhaps miſtruſting my skill, ſince ſo many learned men haue been contented to paſſe by them: ſome againe may happily not well vnderſtande that hath been ſaide, and other ſome, I preſume loue more wayes to the wood then one who knowe well that change of paſture maketh fat calues, and therefore to all ſortes I thought thys chap. very conuenient. You ſhall as I taught you in my booke of triangles, drawe ina figure ſuche circles of the ſpheare, as you are to deale with in this queſtion, as here I haue done it to your hande, partly by ame, whiche for this turne ſerueth as well as the trueſt draught, where in the circle A E C D, repreſenteth our horiſon A B. our meridian, C D, our Eaſt line, E F, the baſe line of the banck propoſed, G K H, the azimuth croſsing hym ſquare, in which the banckes pole zenith muſt needes be by the 22. chapter E N F, is the great circle of the ſpheare wherein the flat of the banke lyeth: A, the North poynt of our horiſon B, the South, D Eaſt, C VVeſt, the center K, our zenith K N, the reclination of the banck, vz. 56. deg. I, the pole zenith of the bancke eleuated aboue G, as muche as N reclineth from K, by the 4. booke and 4. chap. G, the pole zenith of hys baſe line E F, or rather of his perpendiculer flat E K F, declined from the South pointe B, according too the quantitie of G B, founde in the 23. chapter to be $78\frac{1}{2}$. degr. the pointe L is the North pole eleuated in our meridian circle A K B, aboue hys North point A, accordyng to the quantitie of A L, being $51\frac{2}{3}$. degrees.

Your plate being thus laide and well vnderſtood, then begin to deſcant on it thus. And firſt too get the eleuation of this bancke ſince the angle G K B, is knowen to be $78\frac{1}{2}$. deg. his complement B K F, ſhal then be $11\frac{1}{2}$. deg. by the 5. booke, and firſt chap. to which the angle E K A, is equall by the 5. theoreme: E G is a quadrant or 90. deg. to which adding E A, being $11\frac{1}{2}$. deg. it maketh $101\frac{1}{2}$. the angle A K C, then A L, beeing as is ſaide $51\frac{2}{3}$. leaueth his complement L K, $38\frac{1}{3}$. deg. likewyſe G I. beyng 55. deg. leaueth hys complement K I, being the diſtaunce of the bancke's pole zenith, from our zenith 34. degrees. Heere then haue you a ſpherical triangle, videlicet, I K L, whoſe two ſides I K, 34. deg. and L K, $38\frac{1}{3}$. deg. togeather wyth the angle I K L, $101\frac{1}{2}$. deg. are knowen, wherefore by my 13. chap. of triangles, the ſide I L ſhalbe founde $54\frac{1}{2}$. deg. which is the diſtance betweene I. the pole zenith of the banke, and L the North pole, the complement whereof beeing L M, muſt needes be the eleuation ſought for, vz. $35\frac{1}{2}$ degr. Then for the angle of deflexion, you ſhall vnderſtand that the ſame is the arch of any flats horiſon comprehended betweene the meridian of the place, and the meridiã of the flat: as in this figure A K B, is our meridian, becauſe he paſſeth by the pole L, and our zenith K, and I L M, is the meridian of the bancke, becauſe it paſſeth by the pole L, and the banks zenith I, by the definition in the firſt booke & fourth chapter: and therefore the arche O M ſhalbe the degrees of deflexion, which to finde deſcant thus: ſince by the 5. booke & 13. chap. you haue founde the ſide I L, of the triangle I K L, and alſo the angle I L K, or at leaſt if you haue not, you may: the angle O L M, is equal to it by the 5. theoreme: the angle O M L. is a right angle by the 3. def. and 3. theoreme. VVherfore to be ſhort, here you haue the right angled triangle L M O, whoſe one ſide L M, $35\frac{1}{2}$ deg. & his one angle not right O L M, are knowen: wherfore by the 5. bo. 9. cap. the ſide O M, ſhalbe found 28. de. Now laſtly to the angle of the meridiãs aſcen. which is the arch of any flats horiz. cõprehended between the meridiã of your place, & his baſe line, which in this figure is the arch E O, for which you haue the right angled triangle E O A, of which the angle A is a right angle by the 3. def. & 3. theor. & the angle A E O, is knowen, becauſe by the 4. def. it is denominated by N H, being 34. deg. the cõplement of ꝑ recli. the ſide E A, is ſaid before to be $11\frac{1}{2}$ deg. wherefore by the 5. b. 9. c. you ſhal find the ſide E O, $13\frac{1}{2}$ deg. which is the angle of aſcenſ. ſought for, & ſo is ꝑ ſide O A, $7\frac{1}{2}$. de. which is the mounting of our merid. aboue our hor. in this bank or flat, if we had need therof.



Many wayes might you deſcant vpon this figure, to come by the premiſes, as by a little exerciſe you ſhall finde: as for the purpoſe another way, and that a ſhorter way, is thus: if you will begin with the meridians aſcenſion, you may firſt finde all the ſides and angles of the right angled triangle E A O, as I haue laſt before ſhewed. And after that haue you the right angled triangle L M O, whoſe one angle not right L O M, by the 5. theoreme is equall to the angle E O A, of the former triangle knowen, and the ſide O L, is knowẽ by ſubducting the ſide of the former triangle A O, out of A L, the $51\frac{2}{3}$. latitude. Therefore againe by the ſaide 5. chap. you ſhall know the ſide O M, which is the quantitie of the deflexion, and the ſide M L, the poles eleuation aboue the bank ſought for: & ſo I cõclude this chap. leauing the reſt to your diligent indeuour.

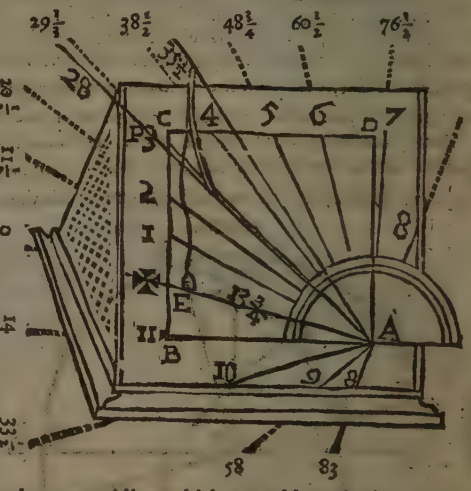
Chap.

Chapter 28.

The angles of reclination, delination, elenation, deflection, and aſcenſion had as before, how to make the dial to a reclining wall, bancke, or flat declining.

HAuing ſpent ouermuch ſpeech about dialles alredie I feare mee, and yet like to ſpende more, the matter yeelding it ſelf in ſuch abundance, I wil for breuities ſake proceed ſtreight with an example, which ſhall bee the diall I made to the bancke in my good conſins garden at Aldermarſton, mentioned in he 23. chapter, where becauſe I wold haue my work laſt, and be ſurely placed, I cauſed a ſquare to be made of foure peeces of timber, eche twelue inches broade, and in length three yardes, equall too the depth of the bancke, as in this figure you ſee A B C D, and to be ſet in euen with the turfe: ſo that of the lower peece, the vpper edge A B, did ſerue for the horiſontall or baſe line of the banke. Then did I appoint the center of this diall in the lower angle Southwardes, vz. in A: In which point A, I placed the center of a woodden ſemicircle, which I had alwayes readie for ſuche like purpoſes, his diameter being 3. foot in length, which I laid euen in the baſe line A B, as in this figure you ſee: for on the graſſe I could make no blinde circle: whichdon, faſtening a threed in the center A, I extended the ſame ſo many deg. aboue the baſe line A B, in this wooden ſemicircle, as our meridianes aſcenſion founde in the 25. or 26. chapter came to, vz. $13\frac{1}{4}$. deg. whiche threede or line croſſeth the ſide B C, in E, this line A E, is the meridian too vs here at Reading or Aldermarſton all is one, ſo little differeth not being but 8. miles betweene: wherefore being ſo, it muſt needs be alſo the 12. a clock line, for in all dialles the 12. is in the meridian of the place: that done, I extende the threede from A, to ſo many degrees in the ſemicircle aboue the meridian A E, as the angle of deflection founde in the 25. or 26. commeth to, vz. 28. and it croſſeth the ſide B C, in P, this line A P, is the place for the cock, and ſo is this bancke prepared for this diall. Therefore nowe am I too betake mee too my *Iewell*, whence I muſt fetch all the houres ſpaces. VVherefore I ſet the *Finiter* vnder the pole according to the eleuatiō of the bank found in the two laſt chapters, whereon then I reckon the degrees of deflection, vid. 28. degrees from the *limb* inwardes, there I finde to cut the 43. meridian, which as I told you in the 19. chap. becommeth our meridian, and repreſenteth the line A E, in the bancke, the *limb* being in this caſe the banckes meridian, vz. the line A P, wherfore you may proceed euen as you did in the declining diall imagining the meridian A E. to bee the plumbe line on the wall: as for example, I reckon on my *Iewel* too the 15. meridian from the ſame 43. meridiā towards the *limbe*, which I find cutting in the *Finiter* $11\frac{1}{2}$. degr. for the firſt houre, wherefore extending the threed from A to $11\frac{1}{2}$. deg. in the ſaid ſemicircle aboue the line A E, I draw thereby the firſt houre for one of the clocke: and ſo proceeding in all reſpectes with the reſt, euen as is done in the diall of the 24. chapter, as by this preſent figure doth more euidently appeare, then by manifolde words: wherein I haue ſet to the degrees of euery houres ſpace, for your better ſatisfaction. Ther is no difference but that there I began the houres from the baſe line, the reaſon was, for that the ſame was there the meridian. The diall being made in maner of this figure, I made the cocke of a barre of Iron iſſuing a ſlope out of the center A, according to the eleuation of the bancke being $35\frac{1}{2}$. deg. ſtanding plumbe ouer the line of deflection A P. This barre was ſupported with two other, on ech ſide one: but in placing of the firſt barre the pretieſt matter I would note vnto you is, that when as by a quadrant his center fixed in A, you lift vppe the ſlope barre too this $35\frac{1}{2}$. eleuation if you let downe a plumbe line from the vppet edge thereof hee then ſhall be truly placed when as this plumbe line hangeth euen on the 12. a clocke line, vz. A E.

To a South flat reclining 56. degrees, declining VVeſt $78\frac{1}{2}$. degrees.



Chapter 29.

Of inclining dials reclining.

THE reaſon, order, and making of theſe is all one with the reclining, but moſt commonly *vice verſa*, as it was in the 19. & 20. chapter betweene North and South declining dials, the one vpwardes, the other downwardes: In which the very conſtitution of the *Iewell* vpon any cituation propoſed, as hath been ſhewed will inſtruct any man of iudgement more by the bare beholding of it then I ſhould doe if I woulde contend to write great volumes of all the diuerſities which are very many. For as well of the reclining as inclining, ſome will fall out to bee right horiſons, ſome oblique, ſome haue the South pole eleuated, ſome the North pole: in ſome our meridian lighteth aboue the baſe line, as all doe yet that I haue ſhewed, in ſome againe our meridian wyll light vnder the baſe line eſpecially in inclining dials, and then may it bee called the meridians deſcenſion. All theſe thinges the *Iewel* ſheweth for the asking, of which he that well vnderſtandeth

all

all this sixt booke cannot bee to seeke, and for him that vnderstandeth not the same, it were great pitie too trouble him with more. I presume that I haue so theorically, or rather vranically shewed the making of dials in this booke, that I may turne you loose to the rest: and therefore if you giue it ouer for once reading you learne not that of me.

Chapter 30.

Howe to knowe in what countrie any declining, reclining, or inclining diall, woulde or of right shoulde serue as an horizon diall, and also to make him shewe the houres of the same place together with yours.

EVery man that hath yet taken vpon him to be the authour of diall making hath delighted too adde some noueltie of deuise with them: as in Sconer, Orontius, & Munster you may see: of which the putting in of the signes with the planetarie houres, and such like hath beene most taken vp and accounted of. Therefore I am to bee borne wythall, if I augment them with a deuise or two of mine: since then there are no declining, reclining, inclining, or East or VVest dials (the North and South reclining & inclining only excepted) but in very deede are dyals of other countries, wrested from their owne deliniation, to serue our turne heere, as in the sixt chapter I haue saide, and that the true meridian of the diall to his owne countrie, is the line where the cock stãdeth: therfore to place other houre lines in any declining or reclining diall to serue his owne longitude shall bee more easie to doe then the declining houres. For when by the 19. 24. and 27. you haue placed the houres of your countrie by helpe of your newe found meridian, as there hath been shewed, you shall againe (your *Iewell* standing as there too the wall or banckes eleuation) count these newe houres from the *limbe* in very like manner as in the oblique and South wall diall you did: & place them in your dyall on each side of the line of deflexion like distaunce as in the nienth & tenth chapter, they were on eyther side of the meridian, that is to say: as you finde the houre circles distaunt from the *limbe* of your *Iewell* by degrees of the *finitor*, so place the houre lines of your diall like distant from the line of deflexion by degrees of the blind circle, among the other before made, but with red or some coloured lines and figures for distinction. This line of deflexion being as is saide the meridian of the other place must needes bee the 12. of clocke line to these new houres, from the which the other houres may easily be numbred accordingly, as by this figure you may better see then by much speech, which is the diall made, in and by the nienteenth cha. in respect of the blacke lines and figures: and the prickte houre lines and figures are drawen and placed by the 9. or rather 10. chapter, according to the walles eleuation being $21\frac{3}{4}$. deg. euen as thogh he did not decline: that is to say, the *finitor* being set as in the nienteenth chapter $21\frac{3}{4}$. degr. vnder the pole all those prickte houre lines are counted on the *Finitor* from the *limbe*, and not from the 60. meridian, as there the other were, and so set on each side of the line of deflexion. Then at the last to conclude our purpose, this rule is generall, that the degrees counted on your *Iewel* among the meridians betweene the *Limbe* & that meridian from whence the houres are counted by the 19. 25. and 28. which in this diall are 60. is the differen. of longitude of such countries frõ ours, whereto the prickt houre lines serue, or more plainely, the diall of right ought to serue, which if the diall decline East must bee added, but if VVest as this doth, then subducted from yours, vz. 60 out of 14. our longitude here at Reading: which cannot be taken: therefore adde (as in all suche caces you must) 360. vnto 14. it maketh 374. then take 60. out of that, you haue left 314 the longitude sought for, of all such places to which the shade of the cock among the prickt houre lines yeeldeth the houres. Nowe to know what countries lie vnder that longitude, you must repaire to Ptolomees, Apians, or any other mans tables (you think best) of regions, cities, prouinces, &c. and seek howe many places you can finde of the same longitude, write them in some voide roome of your diall, for to all those doe the prickt houre lines serue. I haue sought in Apians tables called *Abacus regionum* & can find very few of or neere this 314. long. whereby it should seem that either the world is not much discouered on that coast, or els that the Sea is large that way: only these I noted out of *Carthaga Insula* lying in *America*, whose longi. I find 315. deg. 10. min. which is very neere Also another Iland in *America* called *Spagnolla*, where is great store of *Guiacum*, whose middest is in longitude 315. deg. Also two other partes of *America* in the land of *Peru*, called *Montana Altissima*, in longi. 312. & *Caput de stado* 317. which are neere enough so they exceed not 3. deg. all these I write in this diall, Too bee short, you see that when the Sun giueth 12. of clock to vs it sheweth to any of those places, but 8. of clocke among the prickt houres, & this is that which in my 1. book 12. cha. I mentioned. You wil say perhaps that all these differ in lat: That is not here materiall, for the long. only maketh the difference of houres. VVel, the latit. may cause the Sun to rise & set sooner or later in one of these places then an other, yet keepe they one sight of their houres. But if you will needes knowe to what countrie this diall serueth, both in respect of longitude and latitude, seeke in the tables whether anye of these places before founde, bee in latitude equall

to the walles eleuation or height of the cock, vz. $21\frac{3}{4}$.deg.& the same is he whō you look for: you shal find *Carthaga insula* in lat.22.deg.15.min. which is neere enough to serue your turne, & so I leaue you. Note that in this figure because the line of deflex. fell out iust in one of the houre lines, therefore all the prickt houre-lines of necessitie fall in the rest of them, by which meanes I neede but set too new figures seruing the other countries, and it is done.

Chapter 31.

How to place a flat representing the horizon of any countrie, citie or place in the worlde both according to the longitude & latitude of the same.

AS it is a pleasant thing by the last chap. to set the houres in your dials too the longit. of other countries whereto they serue: So no doubt, it is as pleasant, or rather more pleasant to know how to make a body, which shal haue diuers flats standing both to the longi. & lati. of what places you wil nommate. For if you make a body replenished round with sundrie flats as well reclining inclining, &c. vniformlie as the most do, it is a chaunce if any of them answeare any speciall place you desire either in long. or latit. To performe this matter is harder then a man would take it for: it spent me some studie at the first to compasse it: but now I hope to lay it open enough to the learner. Admit therfore that I were to make a bodie of sundry flats looking euery way some vpwards, some downwards, some this way, some that way, as in times past I haue done with great labor of seeking the angles: which now by help of my *Iewel* I could do with more ease, and that in the same body I would place one flat exactly lying parallell & leuell with the horiz. of Rome, that it might be seen how that horiz. lyeth vnto ours: the first thing I do, I go to Ptolomes or Apiās tables where I find the long. of Rome 37.deg. almost the lat. 41.de. 40.mi. Our longi. here at Reading is 14. well neer, our lat. $51\frac{2}{3}$.deg. then taking 14 out of 37. there resteth 23.deg. the difference of long. of Rome frō Reading, & that Eastwards, bicause that lōg. was greatest. These had, you shal with waxe fixe the *label* $51\frac{2}{3}$.deg. vnder the zenith point of the *reete* leftwards, which point representeth the pole, & the *label* the *Finitor* set too our lat. that done, count among the azi. from that part of the *limb* whereto the *label* is fixed the differ. of long. vz. 23.deg. & on this 23. azi count from the zenith point downwards, the lat. of Rome, vz. 41. 40. there make a sure prick with inke, for in that that the said 23.azi. standeth for the meridian or circle of longitude of Rome, therefore that prick being that it boundeth the poles eleuation, there must needes bee the North point of the horiz. of Rome. Now for that this 23.azi. commeth in towards the center, therefore hys pole zenith or Nadir must needes bee the 23.deg. of the *finit.* beyond the center by the 5.bo. 24.ca. And because the poles zenith & Nadir of the merid. of any horiz. lye in the East & VVest points of the same hor. therfore the same 23.deg. of the *finit.* so coūted beyond the center shall here be the East or VVest point of the hor. of Rome, & in truth must needes be here the VVest point if you conceiue it as wel as I do: wel then, hauing two pointes of the horiz. of Rome, vid. the North point being the pricke made with inke in the 23 azi. & the VVest point being the said 23.deg. of the *finit.* you shall turne about the *reet* & *label* fixed together as before, till you see some one merid. of the *mater* to cut both those points which you shall find too bee the 17. merid. counted from the axtree. This 17.merid. with his match, vz. the 17.merid. on the other side of the axtree, without all doubt represent the whole horiz. circle of Rome euen as in the 4.bo. 9, ca, two merid. made vp alwayes the whole ecliptick circle. Thus your *Iewel* beieng in an excellent constitution for performance of this chap. you shall count the degrees of the said 17.merid. from the said pricke in the 23.azimuth, which is there the merid. of Rome vnto our merid. being the *limb*, which deg. end in the pole point of the *mater* which here is no pole but an intersection, you shall finde them 16. which are the quantitie of the deflexion of this dyall by the def. in the 27. cap. then from the crosing of this 17.merid. with our merid. being as I said the pole counting on his saide match merid. videlicet, the 17.merid. vnder the axtree till he crosse our horison being here the *label*, you shall finde 24.degr. & better, which in our meridians ascension in that flat which shalbe here set to the horison of Rome, but both these angles are more then bargaine: for the drifte of this chap. was no more but to get the declinatiō & reclin. of this proposed flat, which you shall also now haue & those into the vantange. Reckon therefore the deg. of the *label* between the *limbe* & the last intersection of the said match merid. the same you shall find 23.deg. the complement whereof, vid. 67. being the de. of the *label* betwene the same intersection & the center of the *Iewel*, is the declination of the base line whiche must needes be Eastwards from the South, because Rome lyeth that way from vs. Now for the reclination of this flat you shall from the said last intersection in the *label* count on the said match merid. to the pole being as is said 24.de. and so round thence by the deg. of the other 17.merid. tyll you come to 90. which endeth at 66.deg. thereof counted from the pole: directly ouer that 66. degr. make a pricke with inke on the *Reete*, then turne about the *reete* & *label* stil fixed till the *label* lye euen with the Equinoctiall line, & there you shall finde the $22.\frac{3}{4}$ merid. counted from the axtree to cut the said prick last made in the *reet* ouer the said 66 or rather 90.degr. whose deg. from the same prick counted to the pole, are $71\frac{1}{2}$. the reclination of this flat sought for: the complement wherof being the deg. of the same $22\frac{3}{4}$. from the prick to the *label*, vz. $18\frac{1}{2}$.deg. is the mounting of the same flat aboue our horiz. in his bases perpendiculer. Thus in end (since the declinat. is found 67.deg. & the reclination $71\frac{1}{2}$.deg.) I conclude that to place a flat here at Reading, leuel or parallel with the horiz. at Rome, that is to say, to agree with it both in longi. & lat. the same must be a South flat declining East 67.deg. reclining $71\frac{1}{2}$.deg. which by the 22. & 23. chap. you may easily knowe too set, and by the 28. make the dial thereto, and by the last chapter place the houres of Rome.

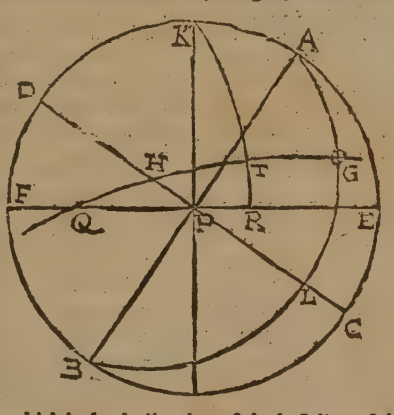
By the way note thus much that though in the constitution of the *Iewel* by this chap. the pole point of the *mater* chaunced aboue the *labell*, yet you shall in the like working manie times finde the pole fall out too bee vnder the *labell*. In euery such case that which here being aboue the *label* was your meridians ascension, shall then bee your meridians descension being vnder the *label*: many suche like notes you shall finde by your own practise and industrie.

Chapter

Chapter 32.

To performe the same by sphearicall triangles.

TO bring you in vse with sphearicall working by triangles, I take this needles paines, first make your platform as here you see, A B C D, is our merid. A B the axtree, A the North pole, C D the Equi. E F our horizon, K our zenith, E North, F South, the center P. East and VVest, E A our eleuation, vz. 51-$\frac{2}{3}$.deg. C L the difference of longitude, vz. 23.deg. A G the eleuation at Rome, vz. 40.degr. 40. min. G the North point of that horizon P H equall too C L, and therefore H the pole Nadir of A L B by the 5. booke 25. chap. being also the VVest point of the horizon of Rome: I drawe therefore a circuler line by ame from G to H, and beyonde letting him to crosse E F, some where at aduenture in Q: This circle G H Q, if hee were truly drawen representeth the horizon of Rome in his right situation to ours Now then I reason thus G L, being the complement of A G must needes be 48$\frac{1}{3}$.deg. which by the 4. def. denominateth the angle G H L, to the which angle D H Q, is equall by the 5. Theoreme: then the angle D H Q, vz. 48$\frac{1}{3}$. taken out of a semicircle, vz. D B C leaueth 131.$\frac{2}{3}$.degr. the angle P H Q, & angle D P F is 38$\frac{1}{3}$.de. the Equinoctials height aboue E F, our horizon P H is 23.deg. as before. Heere therefore haue you a sphearicall triangle P H Q, whose two angles H P Q 38$\frac{1}{3}$.deg. and P H Q 131$\frac{2}{3}$.deg. are knowen with the side lying between them, vz. P H, 23.deg. wherfore by the 5.bo. 17.ca. you shall find the side P Q to be the 67.deg. which is the declination of the base line of this flat proposed, and the angle H Q P (which by the 4. def. is denominated at 90.deg. frō Q by R T to be 18 $\frac{1}{2}$.deg. the flats mouting aboue our horizon E F, whose complement T K, is his reclinat. sought for. I might by this figure get the deflexion & ascension, but they are easie enough by the 26. or 27. ca. now the declination and reclination are had.



Chapter 33.

To describe dials to al maner of declining walles, and also to all East and West reclining and inclining flats more at plaesure then yet hath been shewed without foreknowing the angles of eleuation or deflexion.

SO wonderfull is the copie of operation by this instrument that it is strange so much matter & so great varietie should be cōprehēded in so simple a thing as it is to behold. Truly I am so drencht in the bowels of this *Iewel* that I know not almost which way to turn me, or whē to determine an end. For being now redie to send these 6. bo. to the presse: there sodainely commeth into my head a farre easier course for all declining reclining & inclining dials of what sort soeuer: which for the most part are very troublesom by the 19. 20. & 28, c. in numbring the houres from the new found meridian there. Verily were it not that I challenge the first inuention of the former way, I might here euen blush to think what a compasse, I haue fetcht what extreeme paines & studie it hath cost mee too atchieue the same euen by the racking of the spheare as I may terme it. But it is written of a great clerke, *facilius est addere inuentis quā de nouo componere*, which shall be a sufficiēt tutele for me in this behalf. Neither am I to be more ashamed of this then all other writers before me euen the princes of Astronomie as som of them haue been termed, are to be reproued in that all they haue not taught to make these busie kind of dials by the vse of either the Spheare, Globe, Astrolabe or any other instrument as wel as they haue the other 2. easie & ordinarie dials. But now to the matter, first you shal vnderstand that all declining dials, whose making are taught in the 19. and 20. chapters, and all East and VVest reclining or inclining taught in the 25. cap. are in maner all of one sort, that is to say, their flats represent circles of position to some one lati. or other: as for example, all our declining walles represent circles of position to the 38$\frac{1}{3}$. South latit. euen as our East & VVest reclining flats are decli. walles to the same 38$\frac{1}{3}$ lati. as in the 25. cha. I shewed: to al flats of both these sorts you shal thus presently make the diall without respect either of eleuation or deflexion, which in all my other cap. must be foreknowen. And for your better instruction I wil here shew to make in this maner a diall to the South decli. wall Eastwards 16$\frac{1}{2}$.de. mentioned in the 15. c. VVhich to do I place the *finit.* to our lat. vz. 51$\frac{2}{3}$.deg. vnder the pole, then from the zenith line towardes the *limbe* I reckon on the *finitor* 16$\frac{1}{2}$.deg. rightwards, there do I finde the 16$\frac{1}{2}$.azimuth, whiche representeth this wall proposed, or more plainely, the great circle or horizon in whose flat this wall lyeth, & is the 16$\frac{1}{2}$.circle of position, to those that haue the South pole 38$\frac{1}{2}$.de. eleuated, which being found let him there rest awhile. And now I must haue you (since I can assure you that euery of the dials of this sort are oblique dials) too call to remembrance the def. of an oblique diall mentioned in the 3. chap. & the grounde & reason whēce his lineaments proceed there also shewed: & then if you returne again with this imagination to the saide 16$\frac{1}{2}$.azi. where we left, you wil be redier to tel mee then I haue been hitherto to tel you, that the verye houre lines alreadie on your *Iewel* distinguished by fifteenes, must needes deuide the same 16$\frac{1}{2}$.azimuth intoo hys horizontall spaces seruing this diall: since the *limbe* is still in this constitution our merid. from whence the

houre ſpaces in all dyals muſt be counted. VVherefore to go on: becauſe in South declining dials the South pole is euer eleuated, and in North declining, the North pole, therefore it ſhall not bee amiſſe too turne about the *reete* that this ☉enith and Nadir may chaunge places to the intent you may as well reape the reaſon as driue on your diall. For there belongeth yet more thynges too bee obſerued and foreknowen: of whiche this is one generall. You muſt knowe although I heere teach too deſcribe your dials without firſte ſeeking the angles of eleuation and deflexion: yet for the height of the cocke and his place you muſt, the diall finiſhed, craue their acquaintance, and in the meane time haue a great regarde of them, of which too bee fully inſtructed, firſt you muſt note that on your *Iewell* any two azimuthes lying on eache ſide of the Zenith line, like diſtaunc from it, doe by proſpectiue reaſon make vppe and repreſent one whole great circle of the ſpheare, as in my ſeconde booke and the one and twentie chapter, I haue ſomewhat largely touched, whether reſort, ſo that this ſaid $16\frac{1}{2}$. azimuth with his matche beyng the $16\frac{1}{2}$. azimuth counted from the zenith line on the other ſide doe make vp the whole horiſon or great circle, wherein this wall lyeth. Next to this, ſince you know that the *limbe* repreſenteth the meridian of our horiſon, & that, as I haue often before ſaid, euery wall or flat hath a meridian proper to himſelf lying among the reſt of the meridians, you ſhall know that the *Iewell* being ſet to the conſtitution of this chapter the ſame his meridian as wel in this wall as any other flat, which you wyll make any dial to, by the inſtruction of this chapter lyeth alſo betweene the zenith point of the *reet*, and the neereſt croſsing of the axtree line, with your propoſed azimuth, for whiche cauſe all the houre ſpaces gathered on the ſame azimuth from the ☉enith point of the *reete* towardes the axtree, of neceſsitie muſt in your dial be appointed and ſet from the 12. a clocke line, towardes the line where the cocke ſhall ſtande, that is to ſay, VVeſtwardes of the plumbe line in this diall, becauſe he declineth Eaſt as before is ſaide, or Eaſtwardes if hee had declined VVeſt. Theſe circumſtances ſettled in your minde, then come wee neere to the matter, firſt drawe on this wall a plumbe line, vz. A B, in which pitch the center of your diall vz. C, wheron deſcribe a rounde *limbe* bigge enough for your diall, and within it a blinde circle equall to your *Iewels limb* as you are wont: This done, ſet the *finitor* to our latitude, vz. $51\frac{2}{3}$. his Zenithe poynte downewardes towardes the South pole, as before is ſaide: and from the Zenith poynt towardes the axtree looke where the next 15. houre line (counted from that part of the *limbe* where the Zenith point ſtandeth) doth cut the ſaide $16\frac{1}{2}$. azimuth, and you ſhal find theron 9. degrees for your firſt houres ſpace towardes the cocks place, which by help of your blind circle you ſhal ſet in this diall VVeſtwards of the plumb line: That done, looke againe howe many degrees of the ſame $16\frac{1}{2}$. azimuth are cut by the nexte diſtinguiſhed houre line of the *mater* you ſhall finde $18\frac{1}{4}$. for the ſecond houres ſpace: likewiſe for the third $27\frac{2}{3}$. for the 4. 39. for the 5. 52. for the 6. 70. then can you go no further, except you turne againe your *reete*, that hys Zenith and Nadir may chaunge places: In ſo doing you ſhall get for the 7. houre 93. deg. for the 8. $118\frac{1}{2}$ beyonde eight neuer goe in our countrie: All theſe ſpaces you ſhall by helpe of the blinde circle ſet on the VVeſt ſide

To a South wall declining Eaſtwardes
$16\frac{1}{2}$. degrees.

of the plumbe line of this diall. Then for the houres on the other ſide, you muſt looke to the ſaide matche azimuth that is the $16\frac{1}{2}$. azimuth on the other ſide of the Zenith line, & you ſhall find the ſaid firſt houre line to cut on him $10\frac{1}{3}$. deg. counted frō the Zenith point: the ſeconde houre line cutteth $23\frac{1}{3}$. degrees, the thirde 40. degrees, the fourth $60\frac{1}{2}$. degrees, the fifth $86\frac{1}{2}$. degrees, and ſo foorth if neede were. But ſince all walles ſerue but to 12. houres, therfore howe many houres of the one ſide of the plumbe line needeth aboue 6. the other ſide hath ſo many leſſe, notwithſtanding you may thus put thē in round if you thinke ſtore is no ſore. Theſe laſt houres being put in by help of ỳ blind circle on the other ſide of the plumb line ỳ deſcription of this diall is finiſhed. For the height of the cock & his line of deſle, look the 16. or 17. ca. & perform that, as hath

hath beene before shewed, or rather if you will to the 18. Chapt. whereby you shall neede go no further then this present constitution of your *Iewel* for your whole Dyall *cum pertinentiis*. For if according to the instruction of the same 18. Chapt. you reckon on the *Finitor* from the left part of the *Limbe* inwards $16\frac{1}{2}$ deg. there shalbe the pole Nadir of the said $16\frac{1}{2}$ azimuth lying rightwards of the zenith line, I say his pole Nadir in respect of his face beholding the south pole, and at this saide $16\frac{1}{2}$ deg. of the *Finitor*, you shall finde to cut the $20\frac{2}{3}$ meridian counted from the *Limbe*, which in truth is the meridian of this declining wall wherefore following him towards the south pole you shall finde him to crosse the said $16\frac{1}{2}$ azimuth in the $12\frac{1}{2}$ deg. from the zenith Point of the *Reete*, which by the definition in the 27. Chapt. is the quantitie of the angle of deflexion. And the deg. of the same $20\frac{2}{3}$ meridian betweene this crosing and the pole being there $36\frac{3}{4}$ deg. is theleuation of the south pole aboue this wall, and is the height of the cocke. All the premises you see performed in this present figure.

In the verie like manner shall you worke, for all East and West flats reclining or inclining, mentioned in the 25. Chapt. but that insteede of the *Finitor* there, you must here place the zenith line to the latitude. And so doe the azimuthes serue your turne in the very selfe same sort, as by this Chapt. compared with the 25. you shall most plainely vnderstand, the base line of the bancke or flat, being 12. of clocke: note that the saide azimuth with his match must for East and VVest reclining Dyals be counted from the *Limbe*.

Chapter 34.

To reduce all reclining and inclining flats declining vnto East and West, reclining and inclining flattes to some one latitude or other, and thereby most easily to make the Dyall.

THe reclination and declination of any flat being proposed or else taken by the 23. Chap. you shal thereby get the angles of eleuation and deflexion as is taught in the 26. & 27. Chapt. which had, if you finde there the North pole eleuated then by the 25. Chapt. if south pole, then by the 16. 17. or 18. Chap. you may as easily by the said angles of eleuation and deflexion get the latitude and reclination, as in the 25. chap. by the latitude and reclination, you got the deflexion and eleuation, and that in this manner. Reckon the angle of deflexion giuen on the *Limbe* of the *Reete* from the zenith point, thereto lay the *Label* whereon from the *Limbe* inwards count theleuation giuen, and the azimuth there crosing the *Label* counted from the *Limbe* is the circle of reclination, whose degrees to the zenith is the latitude, wherein that reclination is to be taken that is to say the latitude of that countrie whereto the flatte proposed shalbe an East or West, reclining or inclining flat, or more plainely where the same flat lyeth in one of the circles of position.

For Example the bancke at Aldermarston his reclination found by the 23. Chap. to be 56. deg. and his declination in his base line $78\frac{1}{4}$ deg. whereby in the 26. and 27. Chapt. his eleuation was founde $35\frac{1}{2}$ deg. and his deflexion 28. deg. By this eleuation and deflexion, you shal finde in what latitude this bancke were a bare East or West reclining flat, and how much that reclination there shalbe. Reckon first the deflexion vz. 28. degrees on the *Reetes Limbe* from the zenith point, thereto lay the *Label*, whereon count the eleuation vz. $35\frac{1}{2}$ deg. inwards, and there shall you finde to crosse the *Label* the $56\frac{2}{3}$ azimuth counted from the *Limbe*, which I say is this newe reclination sought for, and the degrees of this $56\frac{2}{3}$ azimuth from this crosing with the *Label* to the zenith you shall finde $44\frac{1}{6}$ deg. the same is this new latitude sought for wherein the said bancke is a West flatte barely reclining $56\frac{2}{3}$ deg. which being had after the line of our meridians ascension and the line of deflexion are placed on the bancke as in the said 28. Chapt. is shewed: you shall insteede of the *Finitor* euen as was done in the 25. Chapt. set the zenith line to this new latitude, that is to say $44\frac{1}{6}$ deg. vnder the north pole leftwards. And thereby the intersections of the 24. distinguished houre circles of the *Iewel* with the same $56\frac{2}{3}$ azimuth, and his match azimuth persue the making of this Dyal in all respects as in the last Chapt. you did, placing the houres in this Dyall from the line of ascention being the 12. of clocke line, as in this last chap. you did from the plumbline, and it commeth to the very same effect with the 28. Chapt. but with more ease a great deale, as by experience you shall trie.

In the verie like manner may you performe inclining Dyals declining, taking a speciall regard by the constitution of the 26. Chapt. which pole it eleuated.

Chapter 35.

To do the same somewhat easier.

BEcause in the working of the last Chap. I referre you to the 26. and 27. Chap. to get theleuation & deflection of any reclining flatte declining, before you can worke your feate, and knowing the working of the 26. Chapter to be in some respect troublesome, I thought good to beate about for some better way for you, and thus much haue I founde: After you haue taken the declination and reclination of any such flat by the 23. and then set your *Iewel* to the first constitution of the 26. Chap. you shall easily thereby streight finde your meridians ascention, and your meridians mounting, which two note in minde, and then set the *Label* to your latitude fixed, and aboue it towards the pole place the zenith point of the *Reete* as much as the meridians mounting commeth to, and there marke where the almicantate counted from the zenith equall to the meridians ascention doth cut the *Label*, for the azimuth meeting him there counted from the *Limbe* sheweth the new reclination sought, which with his match representeth your desired horizon. And the zenith

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point ſtandeth there vnder the pole to your new latitude by which meanes you may proceede as in the 33. and 34. Chapt. is ſhewed. As for example in the ſame bancke.

By his reclination being 56. deg. and the declination of his baſe line being $78\frac{1}{2}$ deg. found in the 23. Cap. I placed my *Iewel* in the firſt part of the 26. Chapt. to a moſt excellent conſtitution repreſenting the ſame and euery neceſſarie circle thereto belonging whither you muſt repaire: and there ſhall you finde that the zenith point was $11\frac{1}{2}$ deg. from the pole, where we finde the 56. azimuth repreſenting this bancke, whoſe degrees betweene his croſsing with the axtree and the zenith of the *Reete* which I called the meridians aſcention, were $13\frac{2}{3}$ deg. and the degrees of the axtreeline betweene the ſame croſsing and the *Limbe* or pole point of the *Maſter* being in truth our meridians mounting were, $7\frac{1}{2}$ deg. if I had made accoumpt of them there, but I then had no vſe for them. Theſe had which you may alwayes haue without any paines for the looking on, I firſt ſet the *Label* to our latitude vz. $51\frac{2}{3}$ deg. vnder the pole, then aboue the *Label* I ſet the zenith of the *Reete* equal to our ſaide meridians mounting vz. $7\frac{1}{2}$ deg. towards the pole, ſo is the pole eleuated aboue it $44\frac{1}{2}$ degrees, and is our new latitude deſired. Then counting from the zenith of the *Reete* among the Almicantares the quantitie of our meridians aſcention vz. $13\frac{2}{3}$ deg. I finde the ſame $13\frac{2}{3}$ almicant. to cut the *Label* in the $11\frac{1}{2}$ deg. from the *Limbe*, which in truth is the complement of the declination as in the 31. Chapter it was, from which this conſtitution now differeth not: but now in the ſame croſsing of the ſaide almicant. with the *Label* you ſhall finde the $56\frac{2}{3}$ azimuth to cut being the reclination deſired: So that now if you keepe the zenith of the *Reete* fixed, you haue him readie placed at the new latitude euen as he was in the laſt Chapt. and the $56\frac{2}{3}$ azimuth your deſired horizon, wherefore let the *Label* now go his way, for the reſt is to be done without him by the 33. Chapt.

Note that if in ſteede of the meridians aſcention among the almicantares you had here numbred on the *Label* the baſe lines declination vz. $78\frac{1}{2}$ deg. from the centre, or his complement vz. $11\frac{1}{2}$ deg. from the *Limbe*, there had you found the ſaid $56\frac{2}{3}$ azimuth without reſpecting the aſcention.

Note alſo when by the ſaid conſtitution of the 26. Chapt. you ſhal at any time conceiue that your meridian is depreſſed vnder your horizon as in diuerſe caſes it happeneth, then that which heere is the aſcention is called the deſcention, and that which here is the mounting is then the depreſsion. And in euery ſuch caſe the zenith of the *Reete* is to be placed vnder the *Label* as here it was aboue.

Chapter 36.

To performe the 31. Chapter ſomwhat more eaſily, or at the leaſt more pleaſingly.

FIrſt ſet the *Finitor* to the latitude of the place propoſed, whoſe horizontall flat you deſire to ſcituate, then reckon inwards among the meridians, the difference of longitude, and the meridian ſo found ſhal cut on the *Finitor* the angle of deflexion of the ſame flatte in this our countrie, euen as in the 19. Chapt. the deflexion found the difference of longitude, which had I reckon this deflexion on the *Limb* of the *Reete* from the zenith point, thereto I lay the *Label* whereon I count againe the latitude propoſed inwards, and there croſſeth the azimuth ſhewing the poſition reclination as I may terme it. And the degrees of the ſame azimuth betweene this croſsing and the zenith point ſheweth the poſition latitude, that is to ſay, the latitude wherein the horizon of the place propoſed is an Eaſt or Weſt reclining flatte equall to this reclination founde or more plainely wherein he lyeth in that circle of poſition, ſuch a one as in the laſt two Chapters are mentioned. VVherefore taking this latitude out of yours, there reſteth the mounting of your meridian if your latitude be the greater, or the depreſsion if the leſſe, according to which if the *Label* and zenith point be ſet in manner of the laſt Chapt. the ſame azimuth at his croſsing with the *Label*, if you count thenſe to the centre, findeth out the baſe lines declination of your propoſed flat, and from the ſame croſsing to the zenith point your meridians aſcention. And hauing nowe theſe, then if by the firſt conſtitution of the 26. Chapter you place the zenith line of the *Reete* according to this declination as there is taught: and then reckoning from the *Limbe* on the axtree line, the mounting of your meridian found, there ſtreight meeteth you the azimuth ſhewing the true reclination in his baſe lines perpendiculer ſought for. By example this will be more plaine which ſhalbe the example in the 31. Chap. of the ſcituation or placing of the horizon of Roome, the latitude thereof being $41\frac{2}{3}$ deg. and the difference of longitude from vs here at Reading 23. deg. both propoſed: Firſt I ſet the *Finitor* to the $41\frac{2}{3}$ latitude vz. $41\frac{2}{3}$ vnder the pole, then from the *Limbe* among the meridians I count the difference of longitude vz. 23. this 23. meridian cutteth in the *Finitor* 16. deg. which is the angle of deflexion of the meridian of Rome from ours here in our countrie. Theſe had I then reckon this angle of deflexion vz. 16. deg. on the *Limbe* of the *Reete* from the zenith point, thereto I lay the *Label*, nowe on the *Label* inwards I reckon the latitude of Roome vz. $41\frac{2}{3}$ degrees, and there do I finde to cut the 73. azimuth counted from the *Limbe* which I call the poſition reclination: And on the ſame 73. Azimuth from the cutting with the *Label* vnto the zenith of my *Reete* I finde $44\frac{1}{4}$ degrees, which I call the poſition latitude, that is to ſay, in that countrie where the latit. is $44\frac{1}{4}$ degrees. The horizon of Rome is an Eaſt or VVeſt reclining or inclining flatte lying in one of the circles of poſition there: therefore taking that latitude vz. $44\frac{1}{4}$ out of our latitude vz. $51\frac{2}{3}$ there reſteth $7\frac{5}{12}$ deg. the difference, which becauſe our latitude is the greater, is the mounting of our meridian in this flatte rightly placed. Theſe knowne you ſhall firſt ſet the *Label* to our latitude vz. $51\frac{2}{3}$ deg. vnder the pole, then place the zenith of the *Reete* according to the other latitude vz. $44\frac{1}{4}$ degrees vnder the

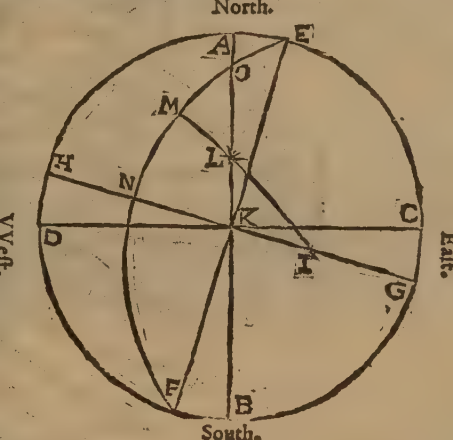
ſame

ſame pole on the ſame ſide, or according to the difference of theſe latitudes vz. $7\frac{1}{2}$ degrees aboue the *Label* becauſe the meridian mounteth, all commeth to one, and then marke where the ſaid 73. azimuth cutteth the *Label* and you ſhall finde betweene it and the centre of the *Iewel* 67. deg. the declination of the baſe line of this flatte ſought for, and from the ſame cutting to the *Limbe* is our meridians aſcention aboue the baſe line, ſo you count it on the ſame 73. Azimuth which to our purpoſe is little pertinent heere but that the *Iewel* will needs do vs the curteſie. The declination of the baſe line thus knowne, you ſhall as in the firſt part of the 26. Chapt. place the zenith point of the *Reete* accordingly, and according to the inſtruction there it ſhall winde from the Equinoctiall 67. deg. towards the pole, where the *Reete* fixed I counte on the axtree line from the ſame pole, the foreſaid mounting of our meridian here found vz. $7\frac{1}{2}$ deg. and there I finde to cut the $71\frac{1}{2}$ azimuth counted from the zenith line which is the circle repreſenting the horizon of Rome in his right ſituation to ours, and his true reclination: but if by the 33. Chapt. you woulde make a Dyall thereto, then muſt you (the zenith point being as before at the $44\frac{1}{4}$ latitude) take the ſaide 73. azimuth and his match to performe your purpoſe. Otherwiſe you may proceede by the 28. Chapter, or rather now by the 40.

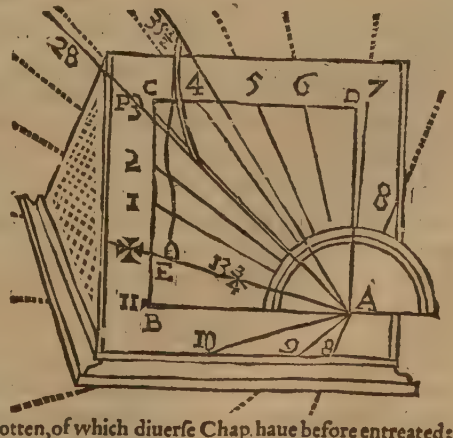
Note that when you haue the poſition reclination and latitude, and thereby the meridians mounting as before: you may ſomwhat eaſier get the true reclination and declination by a Sphericall triangle imagined ſuch a one as A E O is in the 27. Chap. For being that as I haue ſinſe ſhewed in the 37. Chap. the angle E O A is equall alwayes to the poſition reclination: therefore hauing of the triangle A E O the ſide A O knowne with the angle not right E O A you ſhall eaſily by the 5. Booke 9. Chapt. get the other ſides and angle, of which the ſide E O ſhalbe the meridians aſcenſion, and E A the declinations complement, and the angle A E O the complement of the true reclination: hereof looke more in the 37.

Chapter 37.

A moſt eaſie and briefe way to reduce all reclining and inclining flats declining, vnto Eaſt and Weſt reclining flats to a new latitude, otherwiſe then in the 34. & 35. Chap. by helpe of ſphericall triangles.



BEhold yet againe in theſe 4. ſhort Chapters following the intricateſt part of the whole Art of Dyalling moſt plainely performed, not thought of when I wrote the 33. 34. & 35. Chapt. but freſhly came vnto my minde as I was buſilie occupied in cutting the prints for this 6. booke. Better it is that it come too late then neuer: I were beſt now to ſay that there be two courſes in making of Dyals, Longation and Curtation, as the prieſt ſaide to Baluinus in Eraſmus Dialogue called *Alcumiſtica*, and that it was my chance to hit firſt vpon Longation, as in my 19. 20. 25. & 28. Chapters full well appeareth: and yet truely they are very pleſant and profitable in diuerſe reſpectes though not ſo redie for Dyalling as theſe & others, & therfore not to be reiected, yet let no mã ſtand longer on them then to conceiue the reaſon and manner of them. Wel then, now you ſhall haue Curtation, which becauſe I will make ſhort of, behold this firſt figure whoſe lineaments are ſufficiently declared in the 27. Cap. & therefore I neede not repeat them againe repreſenting the firſt conſtitution of the *Iewel* in the 26. Chap. wherein I am in this Chapt to let you vnderſtand that the arch L O is our new latitude ſought for, & the angle L O M our newe reclination mentioned in the 34. and 35. Chap. which are moſt eaſily to be had becauſe the triangle E A O hath all three ſides knowne either by the verie conſtitution of the 26. Chap. or by the 27. wherfore the angle E O A is eaſily had by the 5. Booke 4. Chap. vnto which the angle L O M is equall by the 5. theoreme and is our new reclination deſired, called in the 34. and 35. the poſition reclination. Then taking the arch A O out of A L, our latitude there reſteth L O this newe latitude deſired called in the 34. and 35. the poſition latitude. Laſtly you haue the right angled triangle O L M whoſe one angle not right L O M with the ſubtending ſide O L are knowne, wherefore by the 5. booke 9. Chapt. the other ſides & angle ſhall be knowne, of which the ſide O M is the angle of deflexion and L M the eleuation as in the 27. is ſhewed.



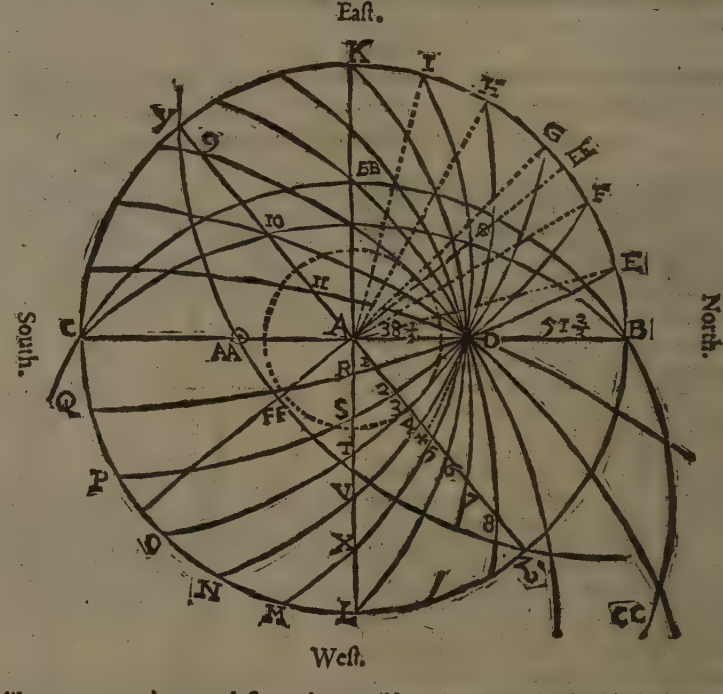
Now do you ſee how eaſily theſe arches and angles are gotten, of which diuerſe Chap. haue before entreated: And therfore me thinks the very lineamẽts of this figure ſhould eaſily ſhew him that hath read the reſt of my book of dyalling with any iudgmẽt, how to place theſe angles on þ dyal euen without þ figure of the 28. ca. which notwithſtanding I haue here ſet for your better conceiuing, for who ſeing the circle E F M to repreſent the

the flat of the bancke proposed, and therein how the notes E O M do stande, will not easily imagine that the degrees of the arch E O being our meridians ascention are to be placed aboue the base line of the bancke, as in this second figure you see E A, and aboue that againe O M to be placed for the angle of deflexion or Gnomons place as in this Dyall you see A P. But now for L M you may conceiue that must stand perpendicular on the flat, being indeede the height of the cocke as in this Dyall you see.

Chapter 38.

A briefe note how East and West reclining or inclining Dyals are to be made two seuerall wayes.

HAuing first placed all the angles on your Dyall, as in the last Chapter, you shall forget that E N F is a South declining flat reclining VVest, as in the 23. Chapt. he was found to be: and that A L is your latitude, and K E N your angle of reclination as it was in the 27. and 28. Chapter. But you shall nowe take O L to be your latitude and the flat O N P to be a bare west reclining flat according to the angle K O N or K P N, wherefore if nowe you take your *Iewel* in hande, and count on the *Limbe* thereof the latitude O L from the pole towards the equinoctiall, and thereto lay the zenith point of your *Reete* fixed, and then choosing out the azimuth counted from the *Limbe* equall to the angle K O N your new reclination, worke your Dyall by him and his match azimuth in all respects as in the 33. Chapt. is shewed.



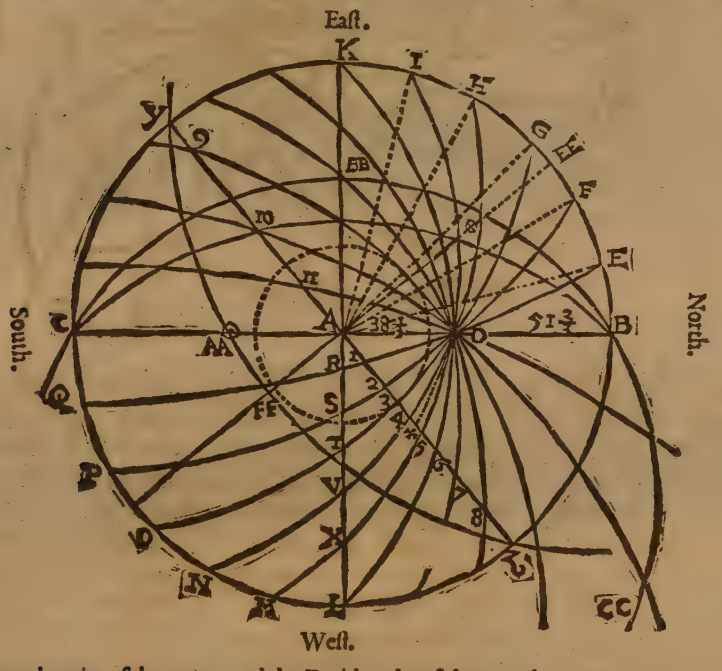
If this way like you not, or that you desire variety, I wil here shewyou to make this dyal by the 5. Book 18. Cap. after another sort. Firste therfore for as much as all East or VVest reclining or inclining flats in any latit. howsoeuer seene or imagined, are verie declining wals to that countrie whose lat. is equal to the complement of the same latitude as I haue said in the 25. & 32. Chap. and by the 13. preamble is partly manifest, therfore if you conceiue not or like not of the making of the Dyals to these East and VVest reclining or inclining flats you may turne them plainly into declining walles. As for example: sinse the latitude O L is $44\frac{1}{6}$ and the angle K O N $56\frac{2}{3}$ deg. as in the 34. Chapt. is shewed, you shall take the complements of them both, and the first vz. $45\frac{5}{6}$ deg. being the complement of $44\frac{1}{6}$ shall be the latitude wherein O N P is a declining wall o being the zenith there. And the complement of $56\frac{2}{3}$ degrees being $33\frac{1}{3}$ deg. is the declination of the wall represented by the said O N P in the said $45\frac{5}{6}$ latitude, and that westwards if it were material But sinse the angles of E O and O M be al redie placed on the flat, therefore it needeth not to seeke so carefully which way such a wall should decline in that $45\frac{5}{6}$ latitude, because which of the 4. wayes so euer hee declineth the degrees of the houres will serue as I shewed in the 20. Chap. And now lastly if you do but lay before you the figure of the 5. Booke 18. Chapt. here present, and imagine the arch B D to be this foresaide latitude vz. $45\frac{5}{6}$ and the circles Z A Y to be this wall declining $33\frac{1}{3}$ deg. you may by the saide 5. Booke 18. Chapt. make the Dyall without more teaching in all respectes as there was shewed.

Chapter

Chapter 39.

How to make a diall to any East or West, reclining or inclining flat, by helpe of spherical triangles most easily.

FOr as much as in the last chap. to make the East or VVest reclining diall, I referred you to the 33. chapt. which doubtlesse is singuler good, but that my example there is a declining dial, or els to reduce the same to a declining wall by the complements, it may be that first you vnderstand not, and the second you vterly mislike. Therefore I wil here briefly teach you to performe the East and VVest reclining after the fyfte booke 18. chap. in other manner then in the last chap. I shewed, whereby you shall not choose, but fullye to vnderstand the 33. chap. Therefore behold this Figure and imagine B D to be your new position latitude mẽtioned in the 34. 35. and 37. chap. videl. $44\frac{1}{6}$. deg. and let the circle B BB C represent the new position reclynation mentioned in the same chapters, reclyning from the Zenith A, according to the arche A BB, beeyng $56\frac{2}{3}$. deg. Here may you beholde on this Figure, being but a poore platforme of your pretence, in what manner the houre circles of the spheare doe cut your proposed flat B BB C. The distances between euery intersection are to be had in all respectes, as was done in the saide 5. booke 18. chap. the case being but a very little altered. For in steed of the arch D A, which in working the same 18. chapt. lieth on the *Limbe* of your *Iewel*, betweene the pole point of the matter, and the Zenith point of the *Reste*, heere you must place the arche B D, and in steede of the angle D A Z, which in the same 18. chap. was common to the finding of euery houres space on the arche A Z, so heere the angle D B *B*B is common to the fynding of euerye houres space on the arche B BB and beyonde if you list vnto C. And euen as the angle B A Y was there the common angle to gett the houres of the arch A Y, so here the angle D B CC is the common angle to get the houres of the arch B CC, and beyond as farre as you list: which angle D B CC is easily had, seing C C B Z is equal to K B B B, the complement of the reclination proposed, vz. $33\frac{1}{3}$. deg. and thereto adding the angle D B Z or A B L videl. 90. deg. there commeth $123\frac{1}{3}$. deg. the angle D B CC. And when you haue all done, you shall find that the working it spherically in this manner, shall differ no iot from the working of the 33. chap. remembring this rule in general, looke whereabouts on your platforme, or on your *Iewel* you see the houre circles to cut your flat or horizon proposed thickest or neerest together, thereabouts bee sure the cocke or Gnomon must stand as here you see they doe betweene B and BB, which I note because you may be sure that those houres from B towardes *B B* are in your diall to be placed from our meridian, being the 12. a clocke line towards the line where the cocke must stand.

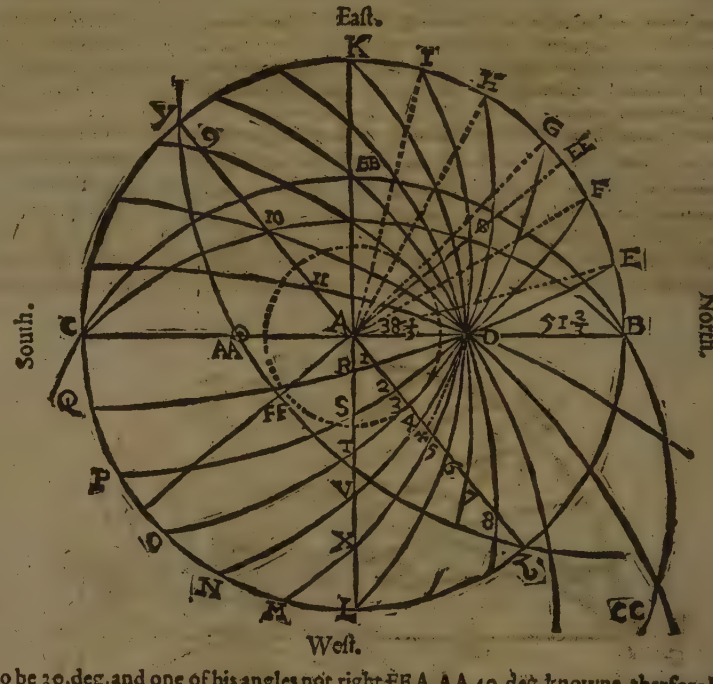


Chapter 40.

Most excellently and easily to make dialles to al maner of reclining or inclining flats declining, by the Iewell *and helpe of spherical triangles.*

I Knowe some will thinke it a great toyle when he hath reclining or inclining flats declining, to seeke newe position latitudes and reclinations by the 34. 35. or 37. chap. and so to goe to worke, the next way about by Lõgation lane: to satisfie them, I suppose the flat Y FF Z in this figure to be a North flat reclining South-

wardes according to the quantity of the arch A FF, vz. 30. deg. declining Eaſtwardes as much as the arche B EE is, vz. 40. deg. Y Z being the baſe line of this flat, and E E the pole zenith of the baſe. The firſt thing you doe you ſhall ſeeke the angle D AA Z, and the arch AA D: both which you ſhall thus eaſily find. The arch A FF is perpendiculer on the circle Y FF Z, by the 3. def. the angle FF A C is equal to EE A B, being the declination, vz. 40. deg. by the 5. theor. Here now haue you the right angled triangle A FF AA, whoſe one ſide A



FF is known to be 30. deg. and one of his angles not right FF A AA 40. deg. knowne, therfore by the 5. book 9. chap. the angle A AA Z ſhalbe known, and alſo the ſide A AA which added to A D maketh the whole arch AA D knowne: both which had, this chapter is eaſily performed euen in maner of the 5. booke 18. chap. For inſteed of the arch A D, which in working, the ſaid 18. chap. you placed on the *Limbe* of your *Iewell* between the pole point of the *mater*, and the zenith point of the *Reet*, you ſhal here place the arch D AA. And there the *Reete* fixed let the angle D AA Z be here the common angle to all the houres of the arch AA Z, euen as in the ſaid 5. book 18. chap. the angle B A Z was common to al the houres of the arch A Z. Likewiſe let D AA Y be here the common angle to all the houres of the arch AA Y, euen as there the angle B A Y was common to al the houres of the arch A Y in all reſpects as I taught in the laſt chap. for taking the angle Z AA D out of 180. there reſteth the foreſaid angle D AA Y, known by the 5. theoreme. you might haue gotten the arch A AA, and the angle D AA Z, otherwiſe, and that in this manner, and I thinke it the ſurer way, you haue the ſpherical triangle A Y AA, whoſe angle Y A AA is equall to the declinations complement, vz. 50. deg. and the angle A Y AA 30. deg. propoſed, the ſide lying betweene theſe angles, vz. A Y is 90. deg. known, therefore by the 5. booke 17. chap. the angle A AA Y ſhalbe found 124. degr. whiche taken out of the ſemicircle Z AA Y being 180. leaueth the angle A AA Z 56. deg. and by the ſame 17. cha. the arch A AA ſhalbe found 37. deg. whereto adding the arch D A, vz. 38½. ſo haue you the whole arch D AA 75½. deg.

And here I thought good to note thus much for the credit of my 33. chap. that if you reckon on the *Limbe* of your *iewel* the ſaid arch D AA, vz. 75½. deg. from the pole, and thereto ſet the zenith poynt of the *Reet* fixed, and there chooſing out the azimuth counted from the *Limbe* equal to the angle A AA Z, viz. the 37. azim. you may by the ſame 37. azim. and his match worke this diall, as in the 33. chap. in all reſpectes, and yet in concluſion wil differ nothing from the premiſſes.

Chapter 41.

To know in what Longitude and Latitude our horizon or any other ſhall repreſent any declining wall propoſed, or els any circle of poſition propoſed.

GOod God if I ſhould bend my ſelfe to inuent but ſo many propoſitions to be performed on my *Iewel* as my courſe capacity could accompliſh, I thinke I ſhould ſpend al my dayes in writing. For whiles I thinke to make haſt to an end, I fare like a dog that goeth in a wheele hauing an endleſſe path to tread, let him make neuer ſo much haſte it helpeth him not til he fynd a meane to get himſelfe quite out. So I haue no other mean to come to an end, but euen here to ſtop and lay a ſtraw as they ſay for this time, this chapter being ended, which cannot but be ſomewhat pleaſurable. As if a man would know in what longitude and latitude

our horizon here at Reading were a south wall declining East 30. deg. or els were the 30. circle of position: euery man perhaps could not performe this, notwithstanding all that which hath byn said. You shall reckon our latitude on the *Label* from the *Limbe* inwards, and lay the same deg. on the 30. azimuth counted from the Zenith line and the degrees of the same 30. azimuth counted thence to the ζenith point shall bee the latitude wherein our horizon is the 30. circle of position, and the complement thereof shalbee the latitude wherein it is a wall declining 30. deg. And the deg. of the *Reetes Limbe* betweene the *Label* and the ζenith point shall bee the deflexion of the diall to that declination and circle of position. Lastly, set the *Finitor* vnder the pole according to our latitude, and thereon reckon inwardes the deflexion before founde, and the meridian cuttyng there the *Finitor* counted from the *Limb* sheweth the the difference of longit. which being added to ours sheweth the longit. desired.

As for example, our horizon here at Reading is in longit. 14. in latitude 51 $\frac{2}{3}$. deg. First I reckō our latitude videl. 51 $\frac{2}{3}$. deg. on the *Label* inwardes and apply the same degree of the *Label* to the 30. azim. counted from the ζenith line, which cutteth off on the said 30. azim. 64 $\frac{2}{3}$. deg. counted thence to the ζenith pointe of the *Reete*, and in the *Limbe* the *Label* cutteth 46. $\frac{2}{3}$. deg. coūted also from the ζenith point, which are the deg. of deflexion of which I will speake anon. But before I proceede further, I conclude that the said 64 $\frac{2}{3}$. degr. are the deg. of latitude in that countrey where our horizon shall lye in the 30. circle of position counted there towardes the ζenith as the circles of position are alwayes reckoned: then if you take the complement of the said 64 $\frac{2}{3}$. deg. vz. 25 $\frac{1}{3}$. deg. the same shalbe the latitude wherein our horizon shall represent a wall declining 30. deg. yet by your leaue you may be in doubt whether this be a South latitude or a North, but you shall haue this rule general, if you once knowe whiche pole is eleuated aboue anye South or South declining wall, you may be sure the contrary pole is eleuated in the latitude whereon that wal standeth, as here seeing the North pole is eleuated 51 $\frac{2}{3}$. deg. you may be sure where this our horizon shall be a south or south declining wal, that countrey hath a South latitude: and therefore this 25 $\frac{1}{3}$. is a South eleuation. But in what longitude withal he shal be a South wal, declining VVestwards 30. deg. that shall the deflexion helpe vs too, being 46 $\frac{2}{3}$. as I before saide. Therefore you shall set the *Finitor* according to the sayde South latitude videl. 25 $\frac{1}{3}$. deg. vnder eyther pole, and thereon rrckon inwardes the saide angle of deflexion vz. 46 $\frac{2}{3}$. deg. where you shall finde the said 68. meridian counted from the *Limbe* to crosse the *Finitor* being the sayde difference of longit. from ours. Now because I propose our horizon to decline VVestwards from the meridian of that 25 $\frac{1}{3}$. latitude, therfore I adde those 68. deg. to our longi. being 14. it maketh 82. deg. the long. desired. So that hereby I conclude my purpose, affirming that our horizon here at Reading shal represent a South wall declining VVest 30. degr. in that countrey where as the longit. is 82. deg. and the South pole eleuated 25 $\frac{1}{3}$. deg. & you do not beleue me me, goe thither and trye it. It is a prety walke for a recreation: wel, yet if you subduct 68. out of 14. (whiche without adding first 360. thereto you cannot doe) so is it 374. there resteth then 306. the longi. of that coūtrey where our said horiζon is a South wall declining East 30. deg. the same latit. vζ. 25 $\frac{1}{3}$. remayning stil. In the very same maner by hauing regard of the longitude, you may knowe where it is a North wall declining East or VVest 30. deg. since those two are but opposite to these.

Note that the said 30. circle of position is the 69. reclining or inclining flat in the said 64 $\frac{2}{3}$. latit. but whether you will haue him East or VVest reclining or inclining, that shal you euen as easily doe by taking regard of the differences of longitude in maner as before.

VVel then though in the 37. I likened my 19. 20. 25. and 28. chapters vnto longation, hauing since in some respectes lighted on Curtation, yet commeth this fruite (if it be ought worth) out of them: and they are introductions to diuers such like, for which cause I thought good not to omit this chapter although the 30. 36. and diuers other chapters came wholly of them, and therefore I repent not much my paynes.

The conclusion.

THus gentle Reader, an hundred times heartily farewel, beeing sorye that my other 6. litle bookes of the *Iewel* be not ready to go to the presse with these: but I hope by that time these shalbe throughly perused to send the rest after somwhat more industriously performed, I feare some will take it vnkindly that those bookes to come, being chiefly for the bent of this present time to be desired should bee kepte in. But truely I could not doe withall, except I should haue set the cart before the horse: such hath beene my want of leysure through the malice of fortune. And therefore considering I haue kept a needful order in this my woorke by passing from the lowest matters to the highest, the one to explane the other: & that I haue done my vttermost (as is wel knowne) that my leysure would permit, I hope I shalbe the lesse blamed.

The order of the fixe bookes behinde.

THe 7. booke of the Mathematical *Iewel* of singuler and perfect meanes as well to describe as to deuyde the lineaments of my *Iewel*, as of my great quadrant to come: to performe the crosse staffe or any prospectiue proiection of the globe howsoeuer, and of certaine vses of the crosse staffe.

The

The 8.booke of certayne Geometrical propoſitions, and of working both rectilineall and ſpherical triangles *ad minutum*, moſt exactly.

The 9. of Rectifications of fyxed ſtarres, of Parellaxes, of comets, or of the moone, of their diſtances frō the earth, of getting the moones exact place by obſeruation and ſuch like.

The 10.of Coſmography, Geography, Topography, menſurations, diſtances, and ſuch like.

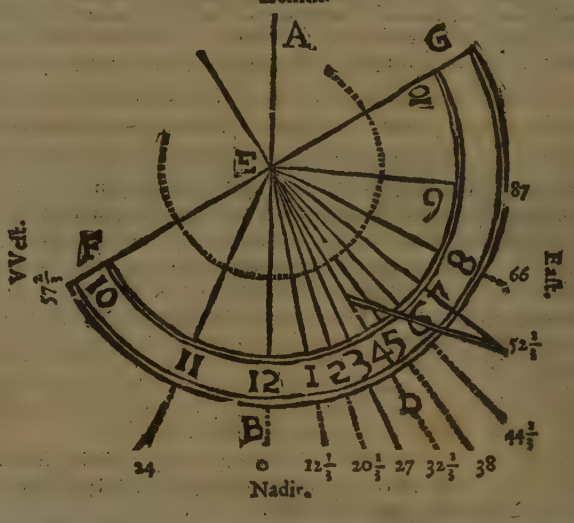
The 11.of the Theoricks of the Sun and moone, and ſetting, their *Radices* of the longitude of regions, and of nauigation.

The 12.of making all manner of dialles Geometrically for artifycers or any other that woulde not enter into the ſtudie of Aſtronomy, ſo exceeding eaſie, that the like hath not (I preſume) beene written in any language.

And in all theſe wil ſtil keep me to the vſe of my *Iewel*, except it be where I muſt perforce vſe my great quadrant and croſſe ſtaffe, to pearce vnto the exact proofe of thinges

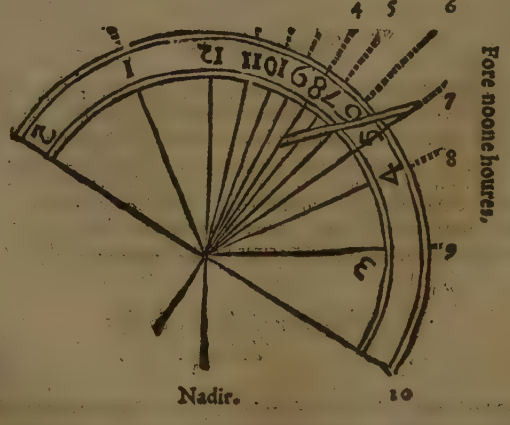
This figure muſt ſtand in the 6.booke 19.chap.and the figure whiche you ſee placed in the ſame 19. chap.muſt be placed topſie turuie according to the wordes zenith and Nadir in the beginning of the 20.chap.

To a South wal declining VVeſt 53 1/3 deg.



This figure muſt ſtand in the 6,booke 20.chap.in the voyd place there left for him.

A North wall declining East 53 1/3 deg.



Imprinted at London by Thomas Dawſon for Walter Venge.

A Table of the most notable fixed ſtarres taken out of *Stadius*, rectified by obſeruation to the yeare of our Lord 1558.

	The names of the fixed Starres.	Signes.	Longitude. deg.	Longitude. min.	Latitude. deg.	Latitude. min.	Part of Latitude	Magnit.	Their nature	Right aſcention. Equinoct. degees.	Right aſcention. min.	Signes.	deg.	min.	Declination. Equinoct. deg.	Declination. min.	Part of declination.
1	Cornu arietis Præcedens.	♈	27	40	7	20	North	2	♂ ♄	22	55	♈	24	55	17	29	North
2	Dexter humerus Cephei.	♈	7	40	69	0	North	3	♄ ♃	317	15	♒	14	47	61	6	North
3	Extrema Eridani Acarn.	♈	21	10	53	30	South	1	♄ ☿	43	0	♉	15	29	40	41	South
4	Andromedæ Scapulum Cingulus	♈	16	20	24	30	North	3	☿	4	33	♈	4	58	28	50	North
5	Andromedæ Scheder Mirach.	♈	24	50	26	30	North	3	☿	11	38	♈	12	40	33	58	
6	Ceti Iuba.	♈	28	40	4	10	South	4	♄	28	7	♉	0	13	7	6	North
7	Ceti Venter.	♈	16	0	20	0	South	3	♄	24	14	♈	2	9	16	7	South
8	Dextrum latus Perſei.	♉	25	50	30	0	North	2	♄ ♃	43	17	♉	15	38	48	4	North
9	Caput Meduſæ. Algol.	♉	20	40	23	0	North	2	♄ ♃	40	28	♉	12	37	39	55	
10	Vergiliarum Seu Pleiadum Trapezum.	♉	24	40	5	20	North	5	♂ ☾	50	52	♉	23	16	24	7	North
11	Vergiliarum Seu Pleiadum Auſtralior.	♉	23	29	4	30				49	42	♉	22	8	23	1	
12	Vergiliarum Seu Pleiadum Borealior.	♉	23	10	4	40				49	29	♉	21	55	23	5	
13	Vergiliarum Seu Pleiadum Minima. *Seuen Starres.*	♉	23	40	5	5				49	53	♉	22	18	23	37	
14	Hiadum ſiue Suculârum. Prima in naribus tauri	♉	29	40	5	45	South	3	♂	58	43	♊	0	53	14	28	North
15	Secunda inter hanc & oculum Boreum.	♊	1	21	4	35				60	10	♊	2	16	15	57	
16	Tertia inter eadem.	♊	1	50	5	50				6a	56	♊	3	0	14	49	
17	Quarta & Palilicij 5.	♊	2	50	2	0				61	10	♊	3	13	18	47	
18	* Oculus Tauri. in oculo Boreo & 6.	♊	2	40	5	0				61	37	♊	3	39	15	48	
19	* Oculus Tauri. Septima Palilicium.	♊	3	40	5	10		1		62	30	♊	4	29	15	49	
20	Humerus. Dexter.	♊	23	0	17	0	South	1	♂ ☿	63	16	♊	23	50	6	20	North
21	* Orionis. Sinister.	♊	11	20	17	30		2	♂ ☿	72	10	♊	13	34	4	49	
22	Aurige Humerus. Dexter.	♊	23	50	20	0	North	2	♂ ☿	82	1	♊	22	41	47	17	North
23	* Hircus. Sinister.	♊	16	0	22	30		1		71	33	♊	13	0	45	5	
24	Hædorum. Præcedens.	♊	13	10	18	0	North	4	♂ ☿	68	51	♊	10	28	40	13	
25	*Eriphen.* Sequens.	♊	13	0	18	0				68	39	♊	10	17	40	12	
26	* Sinister pes Orionis.	♊	10	10	31	30	South	1	♃ ♄	72	56	♊	11	56	9	12	South
27	Stella Polaris Cynoſura.	♊	21	10	66	0	North	3	♄ ☿	5	2	♈	5	30	88	24	North
28	Balthei vel Cinguli Orionis. Præcedens.	♊	16	20	24	10	South	2	♄ ♃	77	32	♊	18	33	1	18	South
29	Balthei vel Cinguli Orionis. Media.	♊	18	20	24	50				79	25	♊	20	17	1	48	
30	Balthei vel Cinguli Orionis. Sequens.	♊	20	20	25	50				81	18	♊	22	1	2	39	
31	* Canobus in Argo naui.	♋	8	10	75	0	South	1	♄ ♃	93	24	♋	3	7	51	38	South
32	* Maior *Seirius.*	♋	8	40	39	10	South	1	♃ ♂	96	58	♋	6	26	15	55	South
33	* Canis Minor Procion.	♋	20	10	16	0				109	28	♋	17	58	6	7	North
34	Caput ♊ Precedens Apollo	♋	14	20	9	40	North	2	☿	106	47	♋	15	28	32	18	North
35	* Sequens. Hercules.	♋	17	40	6	15			♂	110	4	♋	18	32	28	29	

36	Asellus {Boreus.	♌	1	20	2	40	North																				
37	Asellus {Australis.	♌	2	19	0	10	South	4	♃ ☉			124	13	♌	1	58	22	28									
									♂ ☾			124	34	♌	2	18	19	29									
38	Pectus Cancri. Præsepe.	♌	1	10	♋	4	North	ne	♂ ☾			123	21	♌	1	8	19	56	North								
39	Humerus Vrsæ ma. Dubhe.	♌	11	40	49	0		2	♂			161	7	♍	9	33	62	33									
40	Lucida Hidri.	♌	21	♋	20	30	South	2	♄ ♀			138	24	♌	15	56	4	58	South								
41	Regulus. Cor leonis.	♌	23	30	0	10	North	1	♃ ♂			145	53	♌	23	34	13	51	North	13.48	24.44						
42	Leonis {Ceruix.	♌	23	10	8	30		2	♄			148	30	♌	26	16	21	49		21.44	27.32						
43	* {Cauda.	♍	15	30	11	50	North	1	♄ ♀			171	24	♍	20	39	16	36		16.42	21.43						
44	Caude, {Prima, {Alioth.	♍	30	10	53	30						187	53	♎	8	35	57	35		58.4	10 3						
45	Vrsæ, {Media,	♍	9	0	55	4♋	North	2	♂			195	13	♎	16	31	56	55	North	56.57	18.33						
46	Maioris. {Vltima. {Benanat.	♍	20	50	54	0						202	9	♎	23	56	51	12		51.16	24.58						
47	Preuindemiatrix Protrig.	♎	3	10	15	10																					
48	Sinister Humerus Bootis.	♎	10	40	49	0	North	3	♄ ♀			189	2	♎	9	50	12	38									
49	Hastile Bootis.	♎	26	40	53	35		3	♄ ☿			212	35	♏	4	52	40	6									
								4	♄ ♃			226	14	♏	18	42	39	13									
50	Corui {Rostrum.	♎	6	20	21	40	South																				
51	Corui {Ala dextra.	♎	5	30	14	50		3	♄			176	43	♍	26	26	22	18									
									♄ ♂			178	59	♍	28	54	15	45	South								
52	* Arcturus Bootes.	♎	18	0	31	30	North	1	♂ ♃			209	1	♏	1	10	22	0	North	22.13	1 48						
53	* Spica Virginis.	♎	17	40	2	0	South	1	♂ ♀			195	51	♎	17	12	8	48	South								
54	*	♏	27	20	1	10	North																				
55	* Frontis Scorpij. {Borealior	♏	26	40	1	40	South	3	♂ P ♄			235	22	♏	27	39	18	17									
56	* Frontis Scorpij. {Media	♏	26	40	5	0	South					233	57	♏	26	17	21	3									
	* Frontis Scorpij. {Australior.											233	6	♏	25	27	24	17	South								
57	Lances {Australis.	♏	9	0	0	40	North																				
58	Chele {Borealis.	♏	13	10	8	30		2	♄ P ♂			216	49	♏	9	13	13	52									
									♃ ☿			223	17	♏	15	46	7	41									
59	Palma Ophiuchi.	♏	27	0	12	30																					
60	Lucida Coronæ Gnosiæ.	♏	5	40	44	30	North	3	♄ ♀			237	21	♏	29	34	8	18									
								2	♀ ☿			228	45	♏	21	45	28	31	North	28 2	22 5						
61	Cor Scorpij Antares.	♐	3	40	4	0	South	2	♄ ♂			240	49	♐	2	53	24	50	South								
62	Caput Engounasi.	♐	8	40	37	30	North	3	☿			252	35	♐	13	57	15	19	North								
63	Caput Ophiuchi.	♐	15	50	36	0																					
64	Caput Iunonij Draconis.	♐	20	40	75	30	North	3	♂ ☿			258	17	♐	19	14	13	7									
									♄ ♂			266	1	♐	26	22	52	10		12.54	20.12						
65	Fidicula Lucida Lyræ.	♑	8	20	62	0		1	♀ ☿			275	0	♑	4	35	38	41		33 29	5 32						
66	Aquila Vultur volans.	♑	24	50	29	10	North	2	♄ ♂			291	42	♑	20	4	7	34		7.58	22.19						
67	Caude ♑ {Precedens.	♒	15	50	2	10																					
68	Caude ♑ {Sequens.	♒	17	20	2	0	South	3	♃ ♄			318	59	♒	16	32	18	10									
												320	26	♒	18	0	17	34	South								
69	Romboides {Australis.	♒	9	20	32	0																					
70	Delphini. {Borealis.	♒	11	9	33	50						303	28	♒	1	14	13	1									
71	Cauda Delphini.	♒	8	29	29	10	North	3				304	6	♒	1	31	13	25	North								
												303	30	♒	1	16	10	5									
72	* Fomahand.	♒	27	59	23	♋																					
73	Cuspis Sagitte. +	♒	1	10	39	20	South	1	♂ ☿			338	30	♓	6	46	33	33	South								
							North	4				294	58	♑	23	8	18	33	North								
74	Cauda Cygni.	♓	0	9	60	0			♀ ☿			307	7	♒	4	46	44	3									
75	Crus Pegasi.	♓	23	10	31	0	North	2	♃ ♂			340	39	♓	9	3	25	36	North	43.57	5.28						
76	Cauda Ceti.	♓	26	40	20	20	South	3	♄			5	23	♈	5	52	19	53	South								

180
30
360

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